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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

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Editor's Column

It's news, they say, when man bites dog. Well, that's just what happened.

The National Association of Secondary-School Principals up and bit back at *Life* magazine for the unfair article about schools and teachers by Sloan Wilson.

Life, of course, was very unhappy about this action-reaction effect, and *Time* (April 21) reported: "Stung by charges that U. S. schoolmen are too much concerned with group adjustment, too little with individual excellence, the National Association of Secondary-School Principals—some 16,500 members, and an arm of the many-limbed National Education Association—last week had issued a call to arms: 'Now is the time for all members of the profession to rise up and make forceful protests against irresponsible and dishonest reporting on secondary education.'"

There is an idea I can buy.

For more than a few years now, education in general and science education in particular have been taking it on the chin from several self-styled experts who haven't attended, taught in, or, in some cases, seriously visited or studied in American high schools at all. Prime weapons in the armament of these critics have been false statistics, misrepresentation of the situation, and overplaying certain faults and shortcomings, most of which school people have been trying to eliminate for years or decades.

We who teach, prepare teachers, administer schools and school systems can stack our work-week up against that of these unfair critics any time they will face it. We, too, are professional people neither ready to give nor accept insults as a mode of resolving issues and solving problems. We are, I firmly believe, ready to face up to our own shortcomings, but we should stop wasting time and energy trying to answer such slanderous allegations as that schools today are charm schools to produce contented cows.

Soon after the NASSP-*Life* episode, David Lawrence's syndicated newspaper column complained about the principals' style of pressure and pointed out that when errors in reporting are committed by the press, there is a ready, even eager, willingness to make corrections. Well, maybe so. But I have had the personal experience of reading and hearing with dismay some very incorrect statistics about science teaching reported by a high government official, an eminent education editor of a leading newspaper, and a leading atomic scientist. In each instance I wrote rather lengthy letters and spelled out the facts of the situation, only to be ignored by the atomic scientist and rejected by the newspaper with the report that no space was available for my reply. In the meantime, the first-named above repeated the incorrect statements at least twice.

I'm not crying about this. What I'm suggesting is that science teachers, along with others in education, first of all become correctly informed themselves and then, when they find they are being treated unfairly, get some iron in the backbone and speak up, fairly, firmly, and with professional dignity.

Robert H. Carleton

THE SCIENCE TEACHER

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REMINDER TO TST READERS AND SUBSCRIBERS

This issue of *The Science Teacher* completes the 1958 spring series. The next issue will be published in September. New and exciting editorial plans are being developed but reader ideas and contributions are welcomed.

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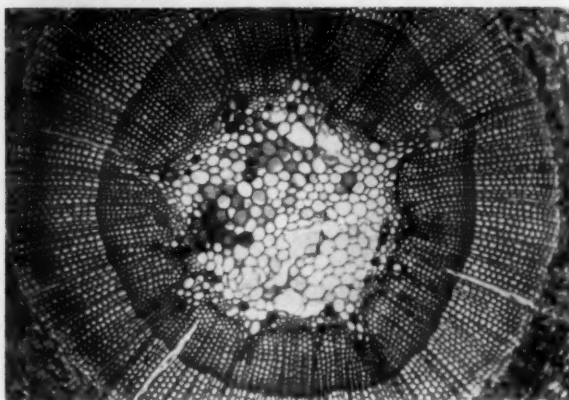
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THIS MONTH'S COVER . . .



is one of a series of photographs submitted in an entry on "Photomicroscopy Technique" in the 1958 program of Science Achievement Awards for Students. The entry, which won Honorable Mention, is the work of Roger S. Hirschberg, a 10th-grade student at Monroe High School in Rochester, New York. As he explained, the nature of his project is "the technique

and procedure employed in producing photomicrographs of cross-sections of specimens."

The cover photograph is a cross-section of a stem of the *Picea abies*, the Norway spruce, magnified 400 times. Photographer Hirschberg gave no data on the specimens he selected or why he chose them. His purpose, he explained, was "to illustrate the method by which photomicrographs may be produced and the technicalities involved in the procedure" rather than "to explore the nature and character of the individual subject matter."

This issue of TST gives a list of the National Metals Awards and Regional Awards winners in the 1958 SAA program—the 7th annual program conducted by the Future Scientists of America Foundation and sponsored by the American Society for Metals. The list begins on page 220. A more detailed list, including the Honorable Mentions, may be obtained on request from NSTA headquarters.

Plans are already being developed for the 1959 SAA program and announcements of details should be available early in the fall. In the meantime, science teachers might well suggest to their students that they devote some of their summer time to developing projects. The cash value of awards in this year's program was \$10,000.

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Readers' Column

The National Science Teachers Association convention in Denver this year was the best teachers convention I have ever attended. I was really inspired by the interesting discussions. The secondary supervisors meeting and the Physical Science Study Committee sessions were outstanding . . . We plan to use the PSSC physics course and materials in our high school physics course next year.

THEODORE WEICHINGER, JR.
Science Supervisor
Horace Mann School
Maryville, Missouri

I have just returned from the extremely successful convention in Denver and I would like to both congratulate NSTA and express my thanks for the splendid arrangements those responsible for the convention made for the publishers' exhibits. I have attended four of NSTA's six national conventions and this one seemed to me to reach a high point.

NEWBURY LEB. MORSE
Senior Editor
Harcourt, Brace and Company, Inc.
New York City

There is something very special about NSTA national conventions which makes them more than well-organized and stimulating events. Somehow a friendliness and an un rushed feeling run through the program and I always come away reinforced in the belief that educators constitute a wide and strongly influential benign group in our national culture. Anyway, it was a very fruitful feeling!

BRENDA LANSDOWN
Department of Education
Brooklyn College
Brooklyn, New York

I enjoyed the meeting at Denver and the chance to report on our progress since last year's meeting. About 150 people attended Curbstone Clinic No. 12 (The Physical Science Study—An Experiment in the Redesign of High School Physics). We have not yet consolidated our records on the crowds that visited the Physical Science Study Committee booth but both presentations seemed to be appreciated by many members at the convention.

Next year should see us in a position to make a major report. We shall have had a year and a half of actual experience with the text in classrooms. With this and the new films, laboratory and teachers books,

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The editors, in addition to Dr. Conant, are Leonard K. Nash, Duane Roller and Duane H. D. Roller. The case histories they present are: Robert Boyle's Experiments in Pneumatics, The Overthrow of the Phlogiston Theory, The Early Development of the Concepts of Temperature and Heat, The Atomic-Molecular Theory, Plants and the Atmosphere, Pasteur's Study of Fermentation, Pasteur's and Tyndall's Study of Spontaneous Generation, The Development of the Concept of Electric Charge.

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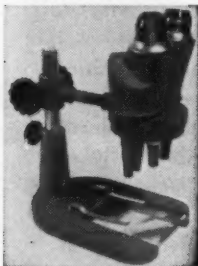
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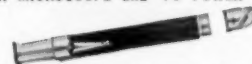
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ELBERT P. LITTLE
Executive Director
Physical Science Study Committee
Cambridge, Massachusetts

The November 1957 issue of *The Science Teacher* has some excellent articles in regard to the Physical Science Study now going on at the Massachusetts Institute of Technology ("The Physical Science Study: Building a New Structure," pages 315-330). It occurs to me that these articles would be extremely valuable for use in our summer institute. Please advise me about reprints.

HOWARD W. LYON
Department of Science
Iowa State Teachers College
Cedar Falls, Iowa

(Editor's Note: Write to the Physical Science Study Committee, 94 Massachusetts Avenue, Cambridge 39, Massachusetts.)

Thanks are due NSTA for the encouragement it gives to both science teachers and students through the program of Science Achievement Awards for Students, conducted by the Future Scientists of America Foundation of NSTA and sponsored by the American Society for Metals.

This is the first year we have entered the contest and I can assure you that the students who were awarded prizes have been greatly encouraged to continue their science experiments and elaborate on them. This is truly because of the stimulation they received from the SAA program.

We hope that the part you are playing in training future scientists will continue in the years to come and that your efforts will be rewarding also.

SISTER MARIANNE, O.S.F.
Principal, Visitation School
Stacyville, Iowa

We are greatly pleased that one of our students was a winner of one of the SAA National Metals Awards. We wish to thank you and the American Society for Metals for making it possible for him to enter this contest. Such an opportunity as you have provided certainly helps unlock latent talent.

DOUGLAS A. TOOL
Chemistry Teacher
Muskegon, Michigan, Senior High School

The SCIENCE TEACHER

Points and Counterpoint in Teaching Science

By JOHN W. RENNER

Assistant Professor of Physics, Creighton University, Omaha, Nebraska

LEO R. BRAY

Science Teacher, Farmer City, Illinois, High School

WILLIAM POWELL

Science Teacher, Edwardsville, Illinois, High School

WHY do we teach science? "To lead a better, fuller life?" When—today, in adulthood, some day in the future? In our country today two major factors must be taken into consideration when a philosophy of science education is being formulated.

(1) Our democratic way of life provides for the education of all the children of all the people. Secondary schools are no longer strictly college-preparatory institutions. They serve those who will go to college, trade schools, and into military service and those for whom high school *per se* is terminal. This means that science instruction must serve general educational aims and purposes.

(2) The rate of increase in the advance of science and technology is indeed a rapid one. Everyone is affected by science; more and more people are becoming involved in the fields of science. The Cooperative Committee on the Teaching of Science and Mathematics of the American Association for the Advancement of Science has observed:¹ "If scientists are to function effectively, they must work in a society where the individuals appreciate science, and, obviously, capable scientists will develop in large numbers in a society where good instruction in science is a part of general education."

What learnings in science should students bring with them to the secondary schools? Toward what goals should these students be directed? What course patterns in science should they study? How should the subject matter within these courses be organized? The following paragraphs give the authors' suggested answers to these questions as developed during many years of experience as classroom teachers.

The Historical Development of Science Education²

Previous to 1890 no course patterns were evident in the science curriculum. Consequently, course offerings were very diverse. In 1893 the Com-

mittee of Ten of the National Education Association set out to bring order into the existing science curriculum chaos. This committee achieved its objective so well that academic regimentation became the "science teaching password" of the day. For example, the committee made course outlines and appended recommended experiments to these outlines. All of this was strictly college-preparatory material. This condition existed for approximately 30 years. About this time the secondary school personnel became alarmed at the regimentation and specialization in science, and in 1920 the Commission on Reorganization of Science was formed. This Commission recommended adherence to the Seven Cardinal Principles; i.e., science should be taught to answer the general and social needs of the students.

The first report which gave a comprehensive review of science teaching in all 12 grades was the 31st Yearbook of the National Society for the Study of Education (NSSE). This report opposed teaching science for purposes of mental discipline and teaching only college-preparatory science. The report emphasized the teaching of broad scientific concepts and principles; i.e., the development of generalizations. Science necessary for general education was the principal goal. The Commission on Secondary School Curriculum of the Progressive Education Association (1938) also pointed out that science should be for general education based on immediate needs. So, today our most prominent philosophies of science teaching proclaim general education and immediate needs, while our courses are still subject matter-centered for the most part. Today's curriculum is still set up in much the same pattern as the college-preparatory courses of the early 1900's.

¹ The factual information given in this report about the historical development of science education can be authenticated by consulting Monroe, *Encyclopedia of Educational Research*, 1952, pp. 1133-1144.

² *Ibid.*

The Contribution of the Elementary School

To understand the philosophy of secondary science education advocated by the authors in this report, this list of "guiding criteria" for elementary science subscribed to by the authors should be considered. These criteria are applicable for kindergarten through grade six, and point to the science training which the writers believe students should "carry away" with them from the elementary school.

1. Science should contribute to the total growth and development of the child.

2. Science should contribute to the child's understanding of his environment. Such topics as weather, climate, transportation methods, plants, small animals, insects, birds, and general topography can all be made subject material for lessons in the elementary grades.

3. Science content should be presented so that it reflects the principles of child development and should proceed from the known and simple to the unknown and more complex. Study of how oxygen sustains the life functions can begin by the observation of the rapid rate of breathing in chicks and continue to a higher level, at which time the entire action of inspiration of oxygen, the use of oxygen in the body, and expiration of carbon dioxide from the body can be investigated.

4. In elementary science children should

- a. begin to acquire skill in the use of the scientific method. This does not mean that a formal lesson is taught on the scientific method, but rather that children be encouraged to make simple observations, ask questions, and seek to answer them from observations.
- b. acquire the ability to relate basic health and body care.
- c. be encouraged to experiment. A scientific experiment does not require elaborate equipment. Many experiments can be performed simply and easily with available material.
- d. begin to appreciate the relation between science and industry. Visits to local industries and/or the use of the many films that industries will furnish free of charge are excellent ways of doing this.
- e. investigate the uses of science in their own community. Studies of the telephone, electrical utilities, fire protection, water, and sanitation are possibilities in almost every community.

5. One of the chief functions of elementary science is to keep alive the innate curiosity of all children.

6. Elementary science should start the student thinking about the relationship between physical and biological science, as well as the relationships

among the separate disciplines within these fields. The value of chemistry in the field of medicine can be shown by a visit to a drugstore.

7. In all the elementary grades experimental procedures should be kept as simple as possible. Stick with the familiar and simpler equipment, because nothing can be as confusing to young people as a vast array of elaborate apparatus.

If a child acquires the learnings that result from using these criteria, he will be ready and eager to begin studying the science course pattern suggested later in this report.

The Secondary School's Contribution to the Scientific Education of Today's Youth

The writers believe that to make a philosophy of secondary school science teaching functional and articulate with the guiding criteria for the elementary school, certain principles must have firm allegiance. The following principles are, in the authors' opinion, guideposts in science teaching. It is believed that every student in science should

1. learn a method of inquiry and proof. Whenever a decision is to be made, facts must be gathered and a conclusion drawn. Secondary school science should be taught so that this ability is developed.

2. develop an interest in science from the general to the specific. The curriculum should be organized so that the field of science is first covered in a general way. Then, as the child progresses (above grade ten) in the school system, the courses should become more specific. This will allow the student to become better acquainted with the specific fields of science and give him that information he needs in order to know whether or not he wishes to choose a vocation in the sciences.

3. develop a knowledge of and an appreciation of the place of science and scientists in our society. The results of science are on all sides of us. The kitchen, the farm, the office, the factory, etc. all use science, and the students in today's classes are tomorrow's proprietors of these businesses. These students must be taught how science and scientists can assist them.

4. develop a sense of responsibility. A sense of responsibility is a necessary attribute which every member of our society must develop. Working with others in the laboratory, following through on experiments, sharing the results with others, feeling that the safety of you and your neighbors in the laboratory depends upon you, the care and maintenance of laboratory equipment, and submitting assigned work on time all contribute to the development of a sense of responsibility.

5. learn the uses of science. Science is not only mysterious equipment and test tubes. We live with science from the time the alarm clock rings in the morning until we snap off the light at night.

6. learn science inductively. The premises of science must be studied inductively. The laboratory must be used to discover and prove the laws, concepts, and principles of science. The results of laboratory experiences can then be used as a basis for further discovery.

7. learn the place of mathematics in science. Mathematics is often the language of science. This language must necessarily, at the high school level, be monosyllabic. However, there should be no hesitation in science classes to teach or review the mathematical elements necessary for a functional understanding of the scientific concept.

Proposed Course Pattern for Science

Students' time must be used as effectively as possible. One of the greatest inefficiencies in secondary science has been the duplication of subject matter between courses. For example, the gas laws are usually taught in physics, chemistry, and to some extent in general science.

In the course pattern that follows, special effort has been made to provide for continuity and to reduce duplication. For example, "earth science" is listed at the eighth-grade level and "physical science" at the tenth-grade level. The eighth-grade course is to contain the elements of geography, geology, and astronomy. The tenth-grade course will contain some of the more advanced topics from these areas and an introduction to physics and chemistry. Such a grouping gives students for whom high school is terminal an acquaintance with all the areas of the physical sciences. When this background in physical science is coupled with the background which will be provided in biological science by the ninth-grade course, the students will leave the tenth grade, or high school, having an acquaintance with most of the areas of science. The ninth- and tenth-grade courses could (and probably would) serve as "feeder" courses for the advanced work which will be studied in the last two years of high school. Specific examples as to how the proposed curriculum avoids overlapping (with the exception of review) will be found where necessary in the following course pattern.

The subject patterns which follow show that the field-covering approach was adopted to isolate the areas of science which are placed at the various grade levels. However, the writers believe that each of the courses should attempt to teach the concepts and generalizations of the science and emphasize

the present and future needs (as far as they are known) of the students. The reader will notice that in grades eight through ten the subject matter has been completely reorganized.

It is proposed that science be required in the secondary schools through grade ten and elective in grades 11 and 12. For about 50-60 per cent of today's secondary school students, high school terminates their education. Consequently, it is the responsibility of the school to acquaint its students with both biological and physical science. This is the reason that biological science is listed in the proposed course pattern at the ninth-grade level and physical science at the tenth-grade level. For the college-preparatory student this is background which is needed before venturing into the advanced sciences in the 11th and 12th grades. In only some of the courses that follow has the content been outlined in great detail. This has been done intentionally. It was felt that to give a detailed outline for some of the courses would seriously hinder the teacher from selecting content and activities which would best meet the needs of the students involved.

Grade Seven—General Science—Required

The seventh-grade science program will follow the general pattern of the science taught in the elementary grades. As in the elementary curriculum, one of the primary functions of the seventh-grade science program will be retaining and encouraging the child's natural curiosity; i.e., the desire to know about things.

Grade Eight—Earth Science—Required

Nearly every child has asked his parents to point out the Big Dipper. Most children are curious about volcanos and various kinds of rocks. The North Pole, China, the people of Siberia, and the plantations of South America are all fascinating topics to youngsters. It is for these reasons and for scientific breadth that we propose the content for the eighth-grade science course be drawn from these three major areas.

1. Astronomy
2. Geography
3. Geology

This course is meant to serve as a "bridge" between the science of the elementary school and the more specific science of grades nine through 12. The specific topics which will be taken from each of the three areas will be selected by teachers who are more aware of the needs of their students than are the authors.

Grade Nine—Biological Science—Required

The proposed course in biological science is to be centered around four central themes.

1. A study of the immediate environment
2. Conservation
3. Life functions of living things
4. Health and body care

It is believed that these four themes will allow the instructor to select content and activities that will meet needs and interests of the students. The traditional taxonomic approach to biological science is discouraged, because it is believed that most children of this age are not sufficiently mature to comprehend and/or appreciate taxonomy.

Grade Ten—Physical Science—Required

This course is relatively new in purpose and grade level. Therefore it is spelled out more than other courses listed above. The course is designed to serve a dual purpose; i.e., terminal science for some students and introduction to physics and chemistry for others. Breadth is emphasized more than depth. The course comprehensively covers material which is commonly taught repetitiously in physics and chemistry. Also, there are retained some of the elements of general science. A minimum of mathematics will be used at this grade level.

1. Advanced earth science and astronomy
2. Concepts of matter and kinetic and potential energy
3. Scientific measurement
4. Gases
 - a. weather
 - b. composition of air
 - c. weight of air
 - d. Boyle's law
 - e. Charles' law
5. Physical and chemical changes
6. Simple machines
7. Heat
 - a. heat transmission
 - b. linear expansion
8. Harnessing power
 - a. steam engine
 - b. internal combustion engines
 - c. water power
9. Magnets and magnetism
10. Current electricity
 - a. basic circuits
 - b. Ohm's law
11. Communication
 - a. telephone
 - b. telegraph
 - c. wireless
12. Atomic energy and radioactivity
 - a. structure of the atom

- b. fission and fusion
- c. defense against radioactive materials

Grades 11 and 12—Chemistry—Elective

The chemistry course outlined below is one which the authors believe will "fit" the needs of most schools; i.e., a course sufficient in scope to interest the student whose formal education will terminate with high school and in sufficient detail for the college-preparatory student. The content has been arranged so as to articulate with the ninth- and tenth-grade courses.

Unit I. Chemistry in Our Modern Era and Review

Unit II. Atomic Structure

1. Structure of the atom and the molecule
2. How atoms unite to form compounds
3. Valence
4. Gay-Lussac's law, Avogadro's law
5. The periodic chart
6. Radioactivity

Unit III. The Chemist's Use of the Periodic Chart

1. Compound formation and valence
2. Types of reactions
3. Chemical equations and problems
4. The electrochemical series

Unit IV. Solutions

1. Solubility
2. Types of solutions
3. The ionic theory of solutions
4. Dilute and concentrated solutions
5. Acids, bases, and salts

Unit V. Gases and Their Properties

Oxygen, hydrogen, nitrogen, ammonia, the halogens, the inert gases

Unit VI. Carbon and Organic Chemistry

Unit VII. Metals, Alloys, and Compounds of Metals

Grades 11 and 12—Physics—Elective

The course in physical science is considered to be a prerequisite for the course in physics. Therefore, the two courses must articulate. The course in physics is not specifically designed to be a college-preparatory course. Due to the foundation in physical science which the students will bring from the tenth grade, the depth of this course will be greater than the ordinary physics course. If the majority of the students in physics are preparing for college, then it is recommended that the background of the students be utilized to delve more

(Continued on page 232)

Rockets and Satellites in the IGY

By HOMER E. NEWELL, JR.

Science Program Coordinator for Project Vanguard, Office of Naval Research; Member, USNC-IGY Technical Panel on Rocketry and Technical Panel on the Earth Satellite Program

THE MOST SPECTACULAR aspects of the International Geophysical Year have been the rocket and satellite programs. Far from being ends in themselves, however, rockets and satellites are tools which the scientist uses to gather new information about the earth, its atmosphere, and surrounding space.

The rocketry and satellite vehicles used in the IGY are technological marvels but their true importance is as vehicles which the scientist can use to carry on experiments above the masking effect of the atmosphere.

Satellites lend these experiments in space the important dimension of time. Rockets, on the other hand, carry instruments over wide ranges of altitude in a brief time.

Rockets

Seven nations are engaged in IGY rocket programs: Australia, Canada, France, Great Britain, Japan, the United States, and the Union of Soviet Socialist Republics. Rockets are used to observe such different phenomena as atmospheric temperature, pressure, and density; atmospheric composition; and the intensity of solar and cosmic radiation.

The United States has been using rockets as tools for the exploration of the upper atmosphere since 1945, when the WAC Corporal was developed for meteorological research. The first rockets used extensively for this purpose were German V-2 rockets sent to this country after the end of World War II. This use of the V-2 illustrates the broad character of science, for the German designers of the V-2, in turn, freely acknowledge their debt to the American rocket pioneer, Robert H. Goddard.

The large V-2 was much too expensive for a research tool, and smaller, less complicated, and less expensive vehicles were soon developed. The US-IGY program uses three types of rocket vehicles: liquid fuel rockets with solid fuel boosters, two-stage



U.S. ARMY PHOTO

Jupiter-C Rocket at Cape Canaveral, Florida, launching the first US-IGY satellite—1958 Alpha—on January 31, 1958. The satellite is the long, slender object perched atop the rocket.

solid fuel rockets, and solid fuel rockets carried aloft to high altitudes by balloons before firing. (This balloon-rocket combination is called a Rockoon.)

The only liquid fuel rockets used in the IGY program are the Aerobee, a high-performance rocket designed expressly for use as a vehicle for high altitude atmospheric research, and the Aerobee-Hi, a more powerful version of the Aerobee. Solid-propellant booster rockets are used with both to provide fast acceleration during the first few seconds of flight, thus minimizing the effects of surface winds on the rocket trajectory. The Aerobee-Hi can reach as high as 180 miles.

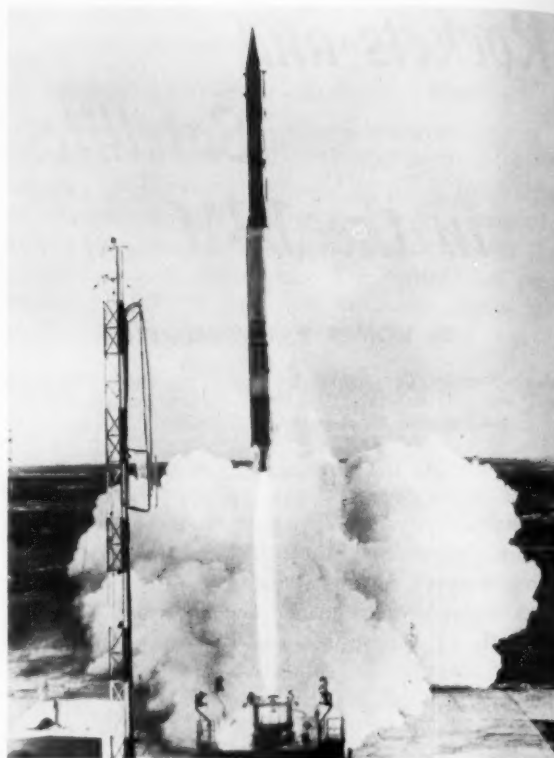
Several types of two-stage solid fuel rockets are being used. In all types the principle is the same; a relatively large first stage propels the smaller second-stage rocket through the dense lower layers of the atmosphere so that the energy of the second stage can be utilized in gaining altitude rather than in fighting air drag. Solid fuel rocket combinations used in the IGY program are the Nike-Cajun, the Nike-Deacon, the Nike-Asp, and the Loki II-Dart. The first part of the combination name designates the first-stage rocket; the second part of the name designates the second stage, which also acts as the instrument carrier. Peak altitudes for the solid fuel rockets are not as high as those for the Aerobee-Hi but some have attained altitudes in excess of 125 miles.

The name "Rockoon" refers to any balloon-launched rocket. Balloon launching eliminates the air drag of the dense layers of the atmosphere and

Rockoon being carried aloft prior to firing. The rocket is covered with a plastic bag as protection against the environment.



USNC-IGY PHOTO



US NAVY PHOTO

Test firing of the Vanguard rocket at Cape Canaveral on March 17, 1958. The test proved highly successful and, as a result, a small test sphere entered into orbit, becoming the second US-IGY satellite—1958 Beta.

enables a relatively small rocket to carry useful payloads to altitudes of 75 to 100 miles. The Rockoons used in the IGY utilize both the Loki-Phase II, sometimes called the Hawk, a solid propellant unit 3 inches in diameter and 5 feet long, and the Deacon, 6½ inches in diameter and 110 inches long. When launched at 80,000 feet, the Hawk can carry a 6.8-pound payload to altitudes above 80 miles.

The US-IGY rocket program calls for the firing of 194 rockets. Approximately 115 rockets have already been fired. Most of the research rockets in the US-IGY program are being fired at Fort Churchill, Canada, where an important rocket launching installation was constructed through the cooperative efforts of the Canadian and US National Committees for the IGY and the defense establishments of both countries. Other US launching sites are at Holloman Air Force Base, New Mexico; White Sands, New Mexico; Point Mugu, California; Guam; and from shipboard. All the Rockoon firings—which extend from the Arctic to the Antarctic—have been made from shipboard. The Nike-Asp rockets to be fired during the solar eclipse of October 12, 1958 will also be launched from shipboard.

The SCIENCE TEACHER

Because complete analysis of the data gathered on even one rocket flight may take weeks or even months, only preliminary results of the IGY rocket program have been published. But even these preliminary results provide new and exciting information on the upper atmosphere and on cosmic and solar radiation.

Here are some of these results: A rocket instrumented for ionospheric studies was sent up during a polar blackout (a radio fade-out due to ionospheric disturbances) for the first time, and the electron density measured; a rocket was fired directly into an aurora and distribution of auroral particles surveyed; X-ray and ultraviolet bursts from the sun were measured during a solar flare for the first time; and atmospheric temperature and density distribution and the chemical composition of the atmosphere have been measured in the Arctic to very high altitudes.

The final results, correlating all the observations obtained by rockets during the IGY, may not be available for several years.

Satellites

Satellites represent an extension of rocketry which can provide means to obtain data on the variation of space phenomena with time and other factors at vast heights and distances. Satellites are also useful for observations relating to the shape of the earth, the integration of map systems, and the distribution of the earth's mass. Both the USSR and the United States are engaged in satellite launching programs. Many nations are cooperating in tracking and ground-based observations; scientists of 13 countries are cooperating closely with the United States in establishing precision radio and optical tracking stations in their countries as part of the program.

At an international IGY meeting in Rome in 1954, it was suggested that participating nations consider instituting scientific, instrumented earth satellite programs.

The Executive Committee of the US National Committee for the IGY (USNC-IGY) decided that such a program in the US was feasible during the IGY and was scientifically desirable. On March 14, 1955, the Chairman of the USNC-IGY transmitted a resolution to the National Academy of Sciences (NAS) and the National Science Foundation (NSF) recommending prompt initiation of a satellite program. This was followed on May 6 by a document covering the proposed scientific and technical program.

The Committee's satellite proposal—calling for sponsorship of the scientific portions of the program by the NAS and the NSF and for rocket design, con-

struction, and launching by the Department of Defense—was accepted by the US Government. On July 29, 1955, the plans of the Committee to launch IGY satellites were transmitted to the Special World Committee for IGY (CSAGI) in Brussels by the Committee Chairman. A simultaneous public statement was issued from the White House.

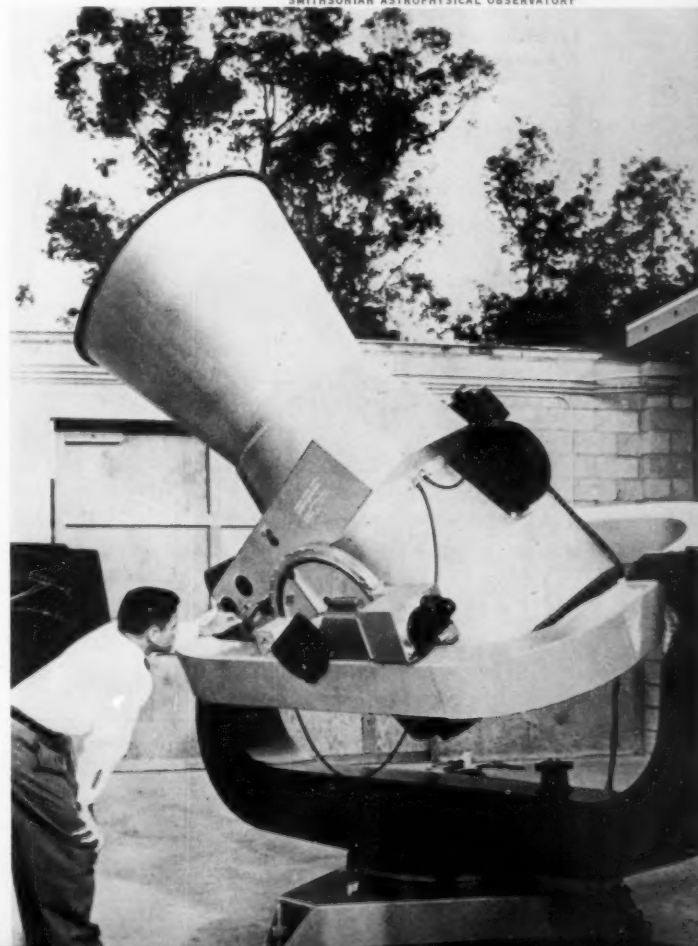
The USSR decision to launch a satellite during the International Geophysical Year was announced at the fourth meeting of the CSAGI, held in Barcelona, September 10-16, 1956.

As of April 1, 1958, five satellites had been launched in the IGY satellite program, two by the USSR and three by the United States.

USSR Satellites: The first USSR satellite was put into orbit on October 4, 1957. It is reported to have been launched by a multistage rocket from a point north of the Caspian Sea. Announcements on Radio Moscow and in the Soviet press stated that satellite 1957 Alpha was a polished aluminum sphere weighing 83.6 kg and 58 cm in diameter, with four antennas (one pair slightly less than 8 feet in length and the second pair 9½ feet). The antennas were folded back during launching but sprung into position when the protective nose cone was jettisoned.

Smithsonian Astrophysical Observatory technicians ready the IGY satellite tracking camera which is used to measure position of earth satellites photographically.

SMITHSONIAN ASTROPHYSICAL OBSERVATORY



May 1958

The satellite carried two radio transmitters, one operating at 20.005 mc and the other at 40.002 mc. The radio transmissions carried telemetered data on temperature.

The US Minitrack network, set up to track satellites emitting signals of 108 mc, the frequency originally announced by the US, was partially adapted for reception and tracking on 20 and 40 mc.

In addition to the satellite itself, both the protective nose cone and the last stage of the launching rocket entered into orbit. For purposes of reporting sightings the rocket was designated 1957 Alpha 1, the satellite 1957 Alpha 2, and the nose cone 1957 Alpha 3. The numerals refer to their relative brightness in the sky.

The rocket, much larger than the satellite, was more often seen by visual observers than either the satellite or the nose cone. The first sighting of the rocket in the United States was reported October 10 by a Moonwatch team in New Haven, Connecticut. ("Moonwatch" is the IGY volunteer visual observation program.)

The orbit of the satellite was elliptical, with an original apogee (greatest distance from the earth's surface) of about 598 miles and perigee (closest approach to the earth's surface) of about 138 miles. The original period (the time required for a complete orbit) was 96.25 minutes. By October 26, the

period had decreased to 95.3 minutes. According to Soviet press reports, the satellite "ceased to exist" on January 4, 1958, presumably having re-entered the earth's atmosphere and been consumed by the resulting heat. The rocket carrier is assumed to have fallen on or about December 1, 1957.

The USSR launched its second satellite, designated 1957 Beta, on November 3, 1957. The following descriptive text was issued on that date by the Soviet News Agency:

"The second artificial satellite developed in the USSR represents the last stage of the carrier rocket, housing containers with scientific instruments.

"The second artificial satellite carries instruments for studying solar radiation in the short-wave ultraviolet and X-ray regions of the spectrum, instruments for cosmic ray studies, instruments for studying the temperature and pressure, an airtight container with an experimental animal (a dog), an air-conditioning system, food and instruments for studying life processes in the conditions of cosmic space, measuring instruments for transmitting the results of scientific measurements to the earth, two radio transmitters operating on frequencies of 40,002 and 20,005 kilocycles, and the necessary power sources.

"The total weight of the apparatus mentioned above, the experimental animal, and power sources amounts to 508.3 kilograms (1120.29 pounds).

"According to observations, the satellite has been given an orbital velocity of about 8000 meters per second.

"According to information received from the satellite, the scientific instruments and control of the life processes in the animal are proceeding normally."

Radio signals from the satellite ceased on November 10. On November 13, *Pravda* stated:

"The program of scientific research connected with taking measurements in the second artificial satellite was planned for seven 24-hour periods. This program has now been completed. The radio transmitters of the satellite as well as the radio telemetrical instruments on board the satellite have finished their work. Further observations of the second artificial earth satellite, for the purpose of exploring the properties of the upper layers of the atmosphere and forecasting its movements, are being made through optical means and radar."

1957 Beta fell to earth on April 13, 1958.

US Satellites: The first US satellite, designated 1958 Alpha, was launched from Cape Canaveral, Florida at 10:48 pm EST on January 31, 1958.

The launching vehicle was the four-stage Jupiter-C rocket. The first stage was a modified US Army Redstone rocket with a thrust of 83,000 pounds.

Launching of the Aerobee-Hi rocket at Fort Churchill, Canada. A high-performance rocket, it is used for high altitude atmospheric research.

US C IGY PHOTO



The second and third stages were composed of concentric clusters of small solid-propellant rockets designed by the Jet Propulsion Laboratory (JPL) of the California Institute of Technology. The final stage, which was to become the satellite, was a single JPL rocket with an added nose section carrying the instruments. The upper stages of the rocket were spin stabilized in order to minimize variations in the direction of thrust if all rockets did not fire simultaneously.

The first stage separated from the upper section at an altitude of 53 miles when its fuel was expended. The upper stages coasted to an altitude of approximately 200 miles. At the apex of the arc, when the rocket was horizontal to the earth's surface, the high-speed stages were fired in sequence, increasing the orbital speed of the satellite to approximately 19,000 mph.

The final stage, which carries the instruments, is 80 inches long and 6 inches in diameter. The instrument payload weighs about 11 pounds. Four whip-like antennas extend from the mid-section of the satellite.

The satellite carries instrumentation to measure the total cosmic ray intensity (designed at the State University of Iowa), density of micrometeoritic matter in the satellite's orbit (designed at the Air Force Cambridge Research Center), and measurements of temperature within the satellite and at its skin (designed at the JPL).

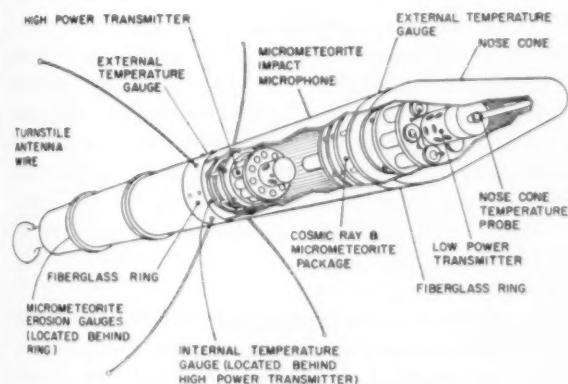


Diagram of US satellite 1958 Alpha.

Two radio transmitters are carried. The higher power transmitter radiates approximately 60 mw of power on 108.03 mc. This transmitter first ceased operating on February 12, after nearly 12 days of continuous telemetering. It later unexpectedly resumed operation for the brief period from February



Nike-Cajun rocket on the launcher at White Sands Proving Ground, New Mexico. This is a solid fuel rocket combination, used for upper atmosphere research.

24 to February 28. The other transmitter, radiating 10 mw of power on 108.00 mc, the primary tracking frequency, was designed to operate for approximately two months. Its signal was still being received on April 1, 1958. Both transmitters telemetered data on instrument readings. The Mini-track radio tracking network, and a supplementary system, Microlock, are tracking the satellite and receiving telemetry signals.

The orbit of 1958 Alpha is inclined at an angle of 33.5° to the equator. Perigee was 224 statute miles, apogee 1573 statute miles, and the period 114.8 minutes.

The second US-IGY satellite, 1958 Beta, was launched from Cape Canaveral, Florida at 7:16 am EST on March 17, 1958, under the direction of the Naval Research Laboratory. The launching vehicle was a three-stage rocket, the third three-stage rocket fired in the Project Vanguard test program. The first and second stages were liquid-fueled rockets, the third stage a solid-propellant rocket. The first and second stages are stabilized and steered by varying the direction of thrust of the rocket motors. The

(Continued on page 228)

A Philosophical Critique of Chemistry Teaching

By WALTER D. BOWLBY

Coral Gables, Florida, Senior High School

THE teaching techniques interpreted in this paper were accumulated over the years, completely untouched by any formal study of philosophy. Then came a course in *Philosophical Bases of Education* with Dr. J. J. Tigert at the University of Miami (Florida). This experience led to an analysis of my own teaching techniques and objectives which proved almost shockingly enlightening. The study cleared up much doubt as to goals, made wavering feet more steady, and instilled greater clarity of purpose. My hope is that a brief distillation of the essence of this experience may be helpful to others.

Wahlquist states (8) the educator is left with four choices: idealism, realism, pragmatism, and eclecticism. A choice indicates equality. With equality indicated, why is a single choice so critical?

There can be no monopoly on truth. It seems to me the real dispute is not what truth is, for truth is truth *per se*. Is it not likely that truth may be found only when tested by all three: idealism, realism, and pragmatism? Truth, to me, seems to start its development by inspirational reasoning on sensations aroused by phenomena. Man is not only a dependent reasoning being, but he is also a phenomenal being with senses; are not the two one? Lastly, this developing truth must be checked for wholesomeness in everyday living.

Practicability is the acid test for truth. Reasoning that is inspired by God, founded on phenomena, and successful in life's applications has the strength of triple armor.

Idealism represents the spirit of one's teaching, realism the body, and pragmatism the activity. We need all three: thoughts, facts, and applications. What is best is not just spiritual, not just phenomenal, not just socially pertinent; it is all three. The highest thought is not imagination alone, it is imagination bridled to the laws of nature and satiating the well-being of man.

The idealist's banner flies in my chemistry laboratory. We fully appreciate what Wahlquist says (8): "Back and beyond the ebb and flow of life is a reign of law, order, design, unity, and system." Many chemical discoveries have come from the wee small voice—visions within one's dreams. We feel God speaks beautifully through his atoms. $E = Mc^2$ is the sunrise of eternity. Reason sees.

The realist's banner also flies in my laboratory. We love to experiment, to shake hands with reality. We realize that work purifies thought, turns wild imagination into reason. Some day we hope to see the whole picture of truth. *Facts and more facts* is the watchword. Facts are the tools of reason.

The pragmatist's banner also flies. We would be the last to suggest that man's imagination does not have to adjust to his environment as well as to his reason and research. In our laboratory we realize the laws born of our imagination and our reasoning experimentation are but the best knowledge of the moment. Reasoning eventually must and does become practical.

With a philosophic rationale as presented briefly above, how does one proceed in the teaching of high school chemistry?

In spirit I consider the job a laboratory one where there is an atmosphere of solving one's problems, of presenting an historical panorama of the milestones in chemistry, and of a close association with the atoms.

Every day we see and discuss phenomena. This is, of course, the realistic approach. However, these discussions lead us to the formulation of generalizations, to the use of imagination, and to the rediscovery of truths and laws applying probably to the whole universe. This approach is idealistic. Last but not least, we consider chemicals from the human standpoint, how they are good as well as

bad for man and how the big effort is always toward better living through chemistry. This is definitely the pragmatic point of view.

This classroom atmosphere is accomplished through the use of many techniques. My analysis shows about 50 techniques which I have acquired over the years. A breakdown of these techniques into four groups—idealistic, realistic, pragmatic, and common—shows a division into the ratio 16:7:20:13, light in realism and heavy in pragmatism with about 25 per cent applying equally to the three philosophic views. Examples of the most important half dozen or so techniques in each group are listed separately below.

Idealistic:

1. Seats and equipment are assigned for better pupil control and safety.
2. Absolute obedience is demanded. Punishment by detention or removal from the course is used.
3. The five laboratory benches are headed by the five highest students selected each marking period. They are in charge of their area, chairmen of committees, correctors of some papers, and tutors. These procedures are aimed at fostering competition among those best able to compete.
4. Lectures are occasionally used to introduce, to summarize, and to give meaning to the abstract.
5. Specific homework is given three times a week with recommendations of nightly half-hour study periods. Required papers are collected, graded, recorded, and returned.
6. Each day one student gives a short talk on a great man in chemistry. The second semester the talks are on the elements. This brings the old and the classical into their lives. These reports are prepared with radio format and are recorded on a tape recorder. Each semester a few of the best talks are selected and re-recorded on a permanent reel for the benefit of future students.

Realistic:

1. Standardized tests are used for prognosis, achievement, diagnosis, and inspiration. National norms are made known to the students.
2. Individual laboratory work is scheduled twice a week. At first the problems are prescribed, later they are developed from student interest and discussion.
3. Students write up in longhand the experiments according to scientific format.
4. Teacher demonstrations are used to clinch important points and concepts as well as to teach proper laboratory techniques.
5. Students are required to write hypotheses

after witnessing certain phenomena shown by the teacher. Many of these are dressed up as "magic," allowing the students full use of imagination.

6. Special emphasis is placed on scientific laws, "the grand generalizations of thought."

Pragmatic:

1. All students are required to learn about their classmates. At the first of the year each one reports his name, ambition, hobby, birthplace, and what he did during the summer.
2. Class discussions are held on marks and the grading system to be used. A vote is taken. Every year the students turn down an offer of all C marks by a vote of two to one in favor of "taking their chances" on getting A's, B's, or D's.
3. Students' problems and interests are developed and used in the laboratory experiments.
4. Marks are issued at a private student-teacher conference where all books are open. The teacher points out the weak and strong points of the student. The student is free to argue his case.
5. A "problem of the day" is presented quite often. A life-situation chemical problem is given. The first six students bringing up the correct solution are given an A for the day. This technique is valuable for getting the class to work and providing physical activity.
6. Student projects are required toward the latter part of the year. The idea is to create some teaching aid for use with future students such as framed pictures, paintings, charts, displays, etc.

Common:

1. Weekly and six-weeks tests are used and include essay as well as objective-type questions. Some of these are set up and corrected by the students.
2. Units of work are built around cultural, environmental, and scientific situations.
3. Students receive a daily grade for submitting clippings from periodicals.
4. Movies are selected along lines of all three of the philosophic views.
5. Selected quotations are placed daily at the top of the blackboard. A few examples follow:

Idealistic

"The laws of nature are but the mathematical thoughts of God." (Kepler)

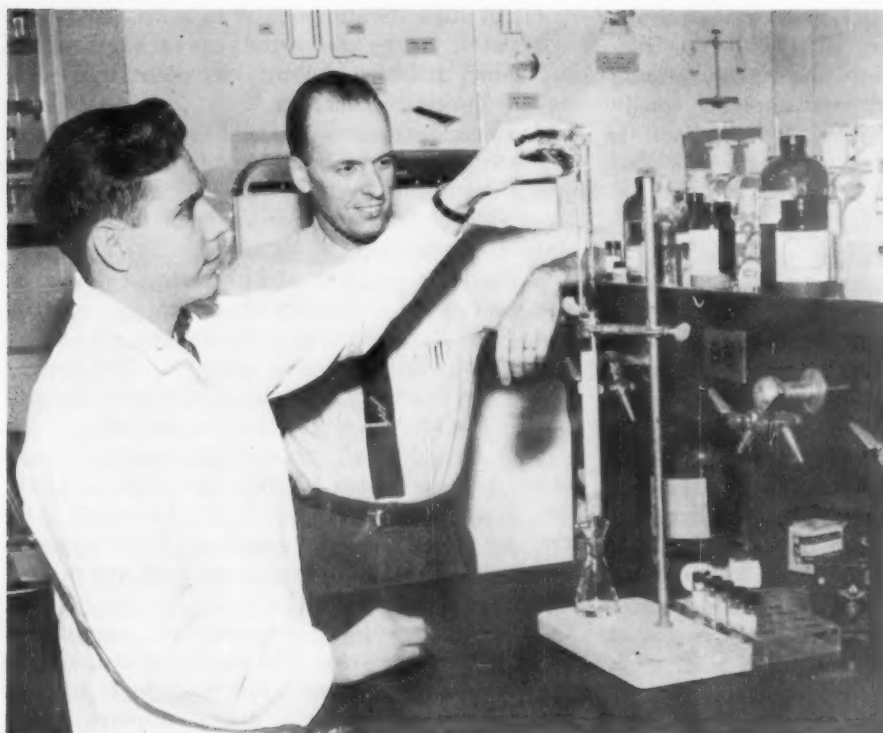
"The most important thing about man is still his view of the universe." (Chesterton)

Realistic

"The road to Utopia is science." (Bacon)

(Continued on page 227)

From Research to Classroom Laboratory



Cincinnati science teacher Leroy Heinlein (right), co-author of these two articles, watches Sanitary Engineering Center chemist Lee Musgrave demonstrate the technique of pouring solvent into a chromatographic column of fine sugar.

PUBLIC HEALTH SERVICE PHOTOS
BY DON MORAN

SEPARATING COMPLEX SUBSTANCES BY CHROMATOGRAPHY

Teacher-Pupil Demonstrations for General Science Grades 7-8-9

By C. LEROY HEINLEIN

Cincinnati, Ohio, Public Schools

and F. M. MIDDLETON

Scientist Director In Charge, Organic Contaminants Studies, Robert A. Taft Sanitary Engineering Center

Background

Many of the materials recovered from water using the carbon filter are very complex; thus, analysis is difficult. There are many different ways to separate chemical materials. An interesting and remarkable way is chromatography.

Chromatography designates a group of specialized and highly sensitive methods for separating a number of very similar substances. Chromatography works because of peculiar adsorption forces which are different for different materials. The following experiments will demonstrate chromatographic

methods for separating the colored pigments that make up colored inks and chlorophyll. Scientists apply these and other methods of chromatography to research problems.

PART I. PAPER CHROMATOGRAPHY

Statement of Problem

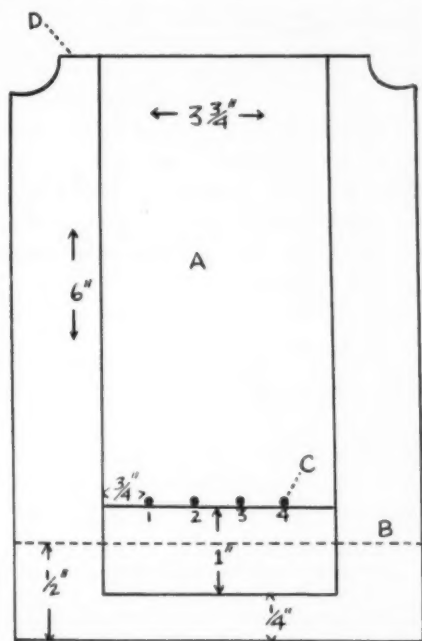
To demonstrate how colored pigments in inks can be separated by paper chromatography.

Materials

1. A quart fruit jar with lid
2. A strip of filter paper at least 1" wide and 6" long. Using a wider strip of filter paper, several tests can be run at once.
3. A solution of ammonium sulfate (prepare by dissolving as much ammonium sulfate in distilled water as will go into solution—approximately 75 g in 100 ml water)
4. Various colored inks
5. Rubbing alcohol

Procedure

A. Draw a light pencil line across the end of the filter paper about 1" from the bottom. Place a very small drop of each ink to be tested on the line so that the drops are $\frac{3}{4}$ " apart. After the drop has been



Drawing 1. Arrangement of fruit jar for paper chromatography

- A. Filter paper fastened to lid
- B. Level of solution in jar
- C. Ink dot
- D. Jar lid (need not be screw type)

These two articles continue the series of demonstrations on the science and engineering of man's environment for healthier living which have been featured in the four 1958 issues of *The Science Teacher* to date (February, pages 15-24; March, pages 76-81; April, pages 130-136). The demonstrations are the result of a distinctive program of collaboration between key secondary school science teachers in Cincinnati, Ohio and members of the staff of the Robert A. Taft Sanitary Engineering Center in Cincinnati—the research arm of the Division of Sanitary Engineering Services of the U. S. Public Health Service, Department of Health, Education, and Welfare. Additional demonstrations are being developed for publication in fall issues of *TST*. In the meantime, the Public Health Service plans to have these first four sets of articles published in a collated reprint, to be available by early fall. Individual copies may be secured without charge. For information or orders, write to: Public Inquiries, U. S. Public Health Service, Washington 25, D. C.

absorbed by the paper it should not be larger than a pea. (See Drawing 1)

B. Attach the filter paper to the lid of the fruit jar with adhesive tape and adjust the paper so that it comes to within $\frac{1}{4}$ " of the bottom of the jar. The lid need not be screw type.

C. Mix the following solution and pour it into the quart jar to a depth of $\frac{1}{2}$ ":

- 10 parts of the alcohol
- 15 parts of the ammonium sulfate
- 75 parts of distilled water

(A thistle tube can be inserted through a small hole punched in the lid. Adding the solution through the thistle tube prevents splashing of the solution on the paper.)

D. Put the lid on the quart jar so that the end of the paper dips into the solution. The spots of ink should be near the bottom of the filter paper but not in the solution. Be careful that the paper does not touch the moist sides of the jar. Let the jar stand and watch as the liquid rises in the filter paper. What happens? The colors of the ink have been chromatographed. This has brought about a separation that might be quite difficult by other means.

Follow-up

Try several different blue inks. Try other colors of ink. Are all the components the same? Make collections of sample papers.

PART II. CHROMATOGRAPHIC SEPARATION OF LEAF PIGMENTS (Teacher Demonstration)

Statement of Problem

To demonstrate how colored pigments of chlorophyll can be separated by column chromatography. This is a modification of the procedure given in Linstead, Elvidge, and Whalley, *A Course in Modern Techniques of Organic Chemistry*, pp. 6-8. R. H. Burttshell, chemist at Robert A. Taft Sanitary Engineering Center, helped develop this modified procedure for columnar chromatography.

Materials

1. Fresh spinach leaves
2. Petroleum ether (boiling range 30°-70° C)
3. Benzene
4. Methyl alcohol
5. Ethyl ether
6. Filter paper
7. Funnel
8. Separatory funnel 250 ml
9. Erlenmeyer flasks 125 ml
10. Sodium sulfate, anhydrous
11. Filter flask
12. Water pump (aspirator for creating vacuum)
13. Glass tube $\frac{3}{4}$ " diameter, 18" long
14. Glass wool
15. Very fine granulated sugar (box should say *very fine* on it)
16. Pipette or medicine dropper

Procedure

A. Preparation of Leaf Extracts. Blot dry two or three spinach leaves with filter paper and place in an oven at 32° C for one hour (air-dry overnight, if preferred). Remove, bruise by grinding in a mortar, and then soak with a mixture of 90 ml petroleum ether (boiling range 30-60°), 10 ml benzene, and 30 ml methyl alcohol.* Let stand until a deep green color is formed. Filter the solution through an ordinary filter paper into a 250-ml (or 500-ml) separatory funnel. Add 50 ml of distilled water slowly, allowing it to run down the sides of the funnel. Swirl funnel *very gently* two or three times and allow to stand for five minutes. Remove the lower layer and discard. Repeat this procedure three additional times. This is necessary to wash the alcohol out of the solution.

Emulsions are very likely to form and some of the yellow materials, carotenes and xanthophylls, are discarded with the emulsified water layer; however,

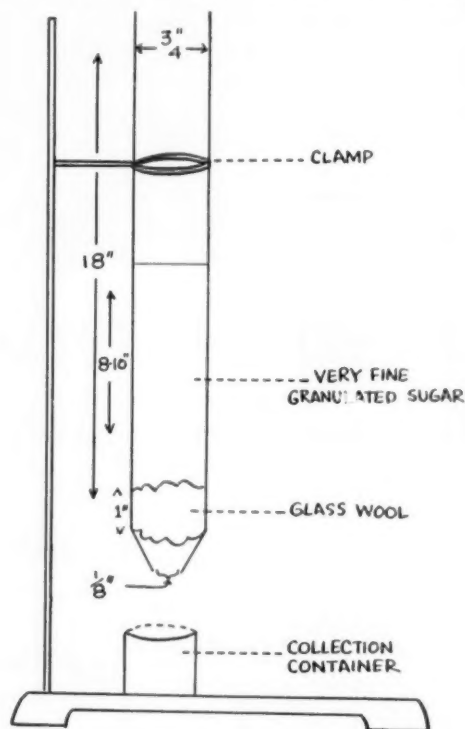
* CAUTION: Pouring and handling of all solvents should be done in a hood or in a well-ventilated room. Do not breathe the vapors and do not use near a flame.

ample material is left for the experiment and it is not worthwhile to try to break the emulsions.

Pour the upper layer into an Erlenmeyer flask and add about 20 g of anhydrous sodium sulfate (Na_2SO_4). Allow the mixture to stand for two hours, with occasional swirling. This step removes the excess moisture from the solvent.

Filter the solution into a 250-ml (or 500-ml) thick-walled filter flask. This removes the Na_2SO_4 . Stopper the flask and connect it to an aspirator or other vacuum source (wear safety goggles). Warm the flask on a hot plate while shaking the flask continuously until only about 5-10 ml of the liquid are left. This evaporation removes the excess solvent (petroleum ether and benzene). (Caution: Do not use open flame for evaporation.) The extract is then ready for chromatographing.

B. Preparing the Column. A glass tube about $\frac{3}{4}$ " outside diameter is constricted about $1\frac{1}{2}$ " from one end and cut off at the constriction, leaving a hole about $\frac{1}{8}$ " or so in diameter. Pack in a small amount of glass wool—do not tamp hard. The tube is now ready for the packing. (See Drawing 2)



Drawing 2. Arrangement of column for chromatographing leaf pigments

Weigh out about 30-35 g of very finely granulated sugar—do not use powdered or coarse granulated sugar. Break up the lumps in a mortar but *do not grind*. Add about 50-80 ml of petroleum ether, boil-

ing range 30-60°. Swirl strongly to suspend the sugar and pour into the tube. The amount of sugar in the tube should approximate one-half of the length of the tube (8-10"). While it is settling tap the clamp holding the tube with a ruler. Catch the solvent running through the column and shake again with the sugar which was not washed out of the flask the first time. Add to the column and repeat until nearly all the sugar is in the column and well packed down. Always keep some liquid over the top of the sugar in the column; the surface of the sugar, once wetted, must never be allowed to dry out until the test is finished.

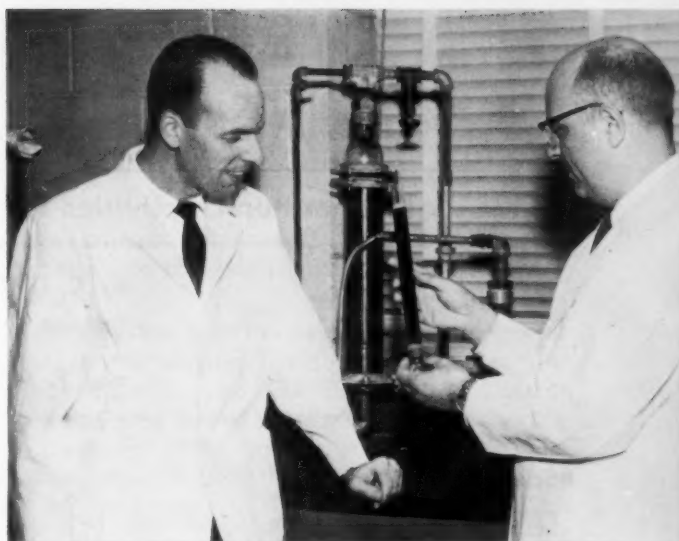
C. Running the Chromatogram. Let the solvent flow through the column until there is less than a centimeter height over the surface of the sugar. With a medicine dropper or pipette add the leaf extract to the column, letting the solution run gently down the sides of the column so as not to disturb the surface any more than necessary. Let the top of the colored solution just reach the surface of the sugar and then wash down the walls again with 4 or 5 ml of petroleum ether, adding cautiously as before. Let this reach the surface of the sugar and then, *gently*, add enough petroleum ether to almost fill the column. Place a clean, numbered flask to catch the effluent and proceed with developing the chromatogram. Keep the column almost full of petroleum ether, adding more when the level drops to within about an inch of the top of the sugar column. Use a total of about 100 ml of petroleum ether after the leaf extract is added.

A light yellow zone quickly washes down and is caught in the first flask. This may not be noticeable if the sample is too small. Another yellow zone appears but proceeds very slowly, and there should be a zone of pure sugar visible between the two yellow zones. When the first zone is washed through the column, change receiving flask and catch the next fraction.

When the last of the petroleum ether is approaching the surface of the sugar add a mixture of 50 ml of petroleum ether and 10 ml of ordinary ethyl ether.** The second yellow zone is quickly washed out with this; as soon as all (or most) is out, change flasks again and catch a strong blue-green zone; when this is almost all washed out, catch the final olive-green effluent in a fourth flask.

This completes the operation. Observe the differences in the colors of the fractions. The first yellow fraction is a mixture of carotenes, the second yellow fraction a mixture of xanthopylls, the blue-green is chlorophyll-a, and the olive-green is chlorophyll-b.

** Ethyl ether is very inflammable.



Teacher Heinlein (left) and SEC chemist Middleton examine a small carbon filter designed for science class use in test and odor detection demonstrations. (See page 196)

For qualitative purposes the chromatogram need not be developed past the point where the zones have separated sufficiently to be visible to the eye.

Follow-up

1. Repeat using other green leaves such as grasses, geraniums, etc.
2. Repeat using autumn leaves of varying colors, or plants with colored leaves.

Applications

Paper chromatography, column chromatography, and many other kinds of chromatography are used to bring about separation of complex mixtures. Knowledge of the chemical identity and nature of materials is essential to help solve baffling problems. Often it is necessary to work with very small amounts of materials as with the small drop of ink. These chromatographic methods are used at the Robert A. Taft Sanitary Engineering Center to help separate and identify chemicals that appear in water in very minute concentration. These chemicals are associated with organic contamination of water.

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HOW SCIENTISTS RECOVER AND STUDY SMALL AMOUNTS OF ORGANIC POLLUTANTS IN WATER

Teacher-Pupil Activities for General Science Grades 7-8-9

By C. LEROY HEINLEIN

Cincinnati, Ohio, Public Schools

and F. M. MIDDLETON

Scientist Director In Charge, Organic Contaminants Studies, Robert A. Taft Sanitary Engineering Center

Background

The quality of water must continually be maintained at a high level because water is a precious and limited resource. Many kinds of materials get into rivers and streams and pollute them. These materials sometimes cause the water to become foul and they interfere with many of the appropriate uses of water such as drinking and use for manufacturing. One very large group of materials can be classed as organic. Some organic pollutants are oils, detergents, phenol (sometimes called carbolic acid), and many hundreds of other chemicals. Other organic materials come from sewage and some are eroded from the soil.

Usually the pollutants are in the water in very low concentrations but even a teaspoonful of some materials in a million gallons of water can cause the water to taste or smell bad. It is necessary for chemists to recover these materials from water and to find out what they are by chemical or other tests. Because it is impossible to test for materials in such low concentrations, they must be concentrated so that enough material can be obtained for study.

The following experiments will help show how some of the materials are concentrated and recovered, and how the odor intensity of chemicals can be determined.

PART I. THE CARBON FILTER

Statement of Problem

To demonstrate how organic materials can be collected and concentrated on activated charcoal.

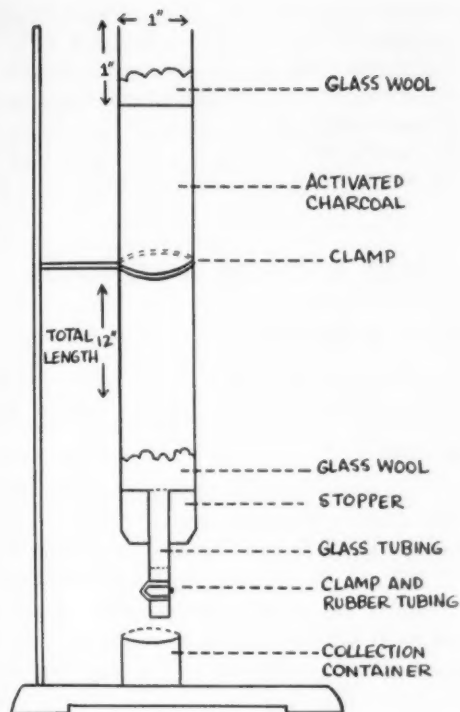
Background

When wood or other organic material is heated to high temperatures in the absence of air, a charcoal, called activated carbon, is formed. This special charcoal has many tiny holes in it and acts like a

sponge toward certain organic materials. In addition, it exerts a strong force (adsorption) that attracts the organic substances. When water containing organic material passes through a column of charcoal, the organic materials stay on the charcoal. In this way, the organic materials from several thousand gallons of water can be collected on a small amount of carbon. To recover the materials from the carbon for further study it is necessary to wash them off with an organic solvent such as chloroform. This is called extraction.

Materials

1. Granular charcoal—1 lb
(This can be obtained from a store selling aquarium supplies. Better results are obtained by using a more highly activated charcoal. A possible source of activated charcoal—Cliff Char. 4 x 10 Carbon—is John P. Harris, Inc., 1791 Howard St., Chicago 26, Ill.)
2. A glass tube about 12" long and 1" in diameter
3. One 1-hole cork or rubber stopper to fit the end of the glass tube
Insert a short piece of glass tubing into the cork. Put a short piece of rubber tubing over the end of the glass tubing and clamp this tube shut with a pinch or screw clamp.
4. Glass wool
5. Ringstand and clamp
6. Four 500-ml beakers or drinking glasses
7. Two test tubes
8. Three medicine droppers
9. The following solutions:
 - A. Make a blue solution by adding a very small amount (about 0.1 g) of methylene blue dye to 500 ml of water. Stir until thoroughly dissolved.
 - B. Add the amount of household detergent that you can get on the end of a pocketknife blade (about 0.1 g) to a liter of water. (Select a detergent that foams generously when shaken with water.)



Drawing 1. Carbon filter

C. A weak phenol solution (furnished by teacher).

Note to teacher: Dissolve 200 mg of phenol in 1000 ml of distilled water.

D. Bicarbonate solution: Dissolve 0.5 g of baking soda in 1.0 l of distilled water.

E. Chlorine solution: Add 5 ml of laundry bleach (select one that contains chlorine) to 1.0 l of distilled water. This is the chlorine solution to use in the test. How is chlorine used at water treatment plants?

Caution: Do not spill the bleach on your clothes or hands. Wash your skin if any does get on it.

Procedure

A. Set up separate columns when filtering more than one solution or wash the carbon column thoroughly after each test by passing 400-500 ml of distilled water through the column.

B. Put the cork, containing the glass tubing, into the 12-in glass tube. Pack a small amount of glass wool or absorbent cotton over the stopper. Fill the tube with the charcoal, leaving about an inch of space at the top. Put some glass wool on top of the carbon to keep it from floating when water is added. (See Drawing 1)

C. Pass some distilled water through the carbon to wash off fine particles and to wet the carbon. Discard the water that comes through. Then clamp the

tube at the bottom. Fill the carbon column with water and let stand, preferably for several hours. Drain before beginning the test.

D. Now slowly pour into the carbon column a glass full of the methylene-blue solution (9A) you prepared. Collect the liquid that comes out of the column. Adjust the clamp so that the material comes through the column by drops and not in a stream. Note what has happened to the color of the liquid.

E. Fill a test tube one-half full of the detergent solution you prepared. Hold your thumb over the mouth of the tube and shake it vigorously. Observe what happens. Select 100 ml of the original detergent solution (9B); pass it through the column. Collect some of the solution coming through the column in a test tube. Shake vigorously. What happens? What was removed? Compare with the

In a taste and odor detection demonstration, Lee Musgrave, SEC chemist, pours water containing dye through a small carbon filter. Waters containing detergents and phenols were poured through the other filters as described in this article.





The Robert A. Taft Sanitary Engineering Center is one of Cincinnati's architectural as well as scientific attractions.

original tube that was shaken. See if you can find out from doing this demonstration how detergents are made.

F. Place 200 ml of the phenol solution (9C) in a clean 500-ml Erlenmeyer flask. Smell it. Describe the odor. Now add 2 ml of the bicarbonate solution you prepared (9D) to the phenol solution. Next add 2 ml of the chlorine solution (9E) to the phenol solution. Mix well and let stand for ten minutes. Smell again. Describe the odor. Is it stronger than before? Phenol gets into water through the discharge of waste products from industry. When chlorine is added to the water at water plants, the material you have just made (chlorophenol) is formed and may cause the bad odor (the taste, you will quickly discover, is even worse) which you have observed.

G. The water plant can treat these odors in different ways. Try the following:

1. To 100 ml of the chlorophenol you have made, add 5 more ml of the chlorine solution. Mix and let stand for 30 minutes. Smell the solution. What has happened? (Excess chlorine acts to form a nonodorous compound.)
2. Now pass another 100 ml of the original chlorophenol solution through the carbon column and collect in a beaker the liquid coming through. Smell this liquid. What is the result? (This represents another type of treatment based on

adsorption used by water plants to remove odorous materials.)

3. Carbon does not remove all organics from water. See if the filter will remove the color from
 - (a) a cola drink
 - (b) tea or coffee
 - (c) water tinted with fruit coloring

PART II. ODOR THRESHOLDS

Statement of Problem

To demonstrate how to measure odors produced by minute quantities of odorous material in water.

Background

Very low concentrations of organic contaminants can cause taste and odor in water. To get information on how much odor is present, a threshold odor test can be run. The nose is the best—and the only way presently known to measure these odors. The noses of people differ as to how much material they can detect. This experiment will explain how to run an odor test. Pilot runs of this part of the experiment were made in the classes of Robert Anderson, science teacher, Woodward High School, Cincinnati, Ohio.

Precautions

Because very small amounts of odor are involved, special precautions will need to be observed. *The water used to dilute the samples has to be odor-free.* The best way to make odor-free water is to slowly pass tap water through a column of carbon like the one used in Part I. This takes out the chlorine and other odorous materials. The preparation room should be as free from odors as possible. Odor tests should not be run immediately after eating. Scented soaps or perfumes should not be used prior to running an odor test.

Materials

1. 12 pint Mason jars with metal lids
2. Carbon column (from Part I)
3. Sample of odorous material (vanilla)
4. Pipette—1 ml
5. Containers—liter jar and/or gallon storage containers

Procedure

A. Prepare 3 or 4 gal of odor-free water by slowly passing tap water through the carbon column into *clean* gallon jugs. Smell the jugs and tops to be sure no odors exist.

B. Wash the pint jars and lids thoroughly. Smell each one to be sure no odors are left on the materials.

If odors remain rinse the jars well in odor-free water.

C. Add 1 ml of vanilla extract to 1.0 l of *odor-free water*. Mix well. This is the stock solution. How many times has the vanilla been diluted?

D. Now take 400 ml of the stock solution and pour half of it into one of the pint jars. Put a number 1 on this jar. Take the remaining 200 ml of stock solution and add 200 ml of odor-free water to it. Mix and pour half of this diluted mixture into another jar. Number this jar 2. Repeat the diluting procedure always using one-half of the amount in the previous step until you have prepared eight jars. These jars should be numbered 1, 2, 3, 5, 6, 7, 9, and 10 from the highest concentration to the lowest concentration. Prepare two other jars containing 200 ml each of odor-free water to represent blanks. Number these 4 and 8, and insert in sequence as shown in Drawing 2. These two jars of odor-free water represent blank controls in the test. Be careful to keep the jars from picking up odorous materials.



Drawing 2. Arrangement of jars for odor test

E. You are now ready to run the odor test. Have a student pick up jar No. 10. Be sure to keep the hands away from the neck of the jar. Shake the jar vigorously with the lid tightly closed, then remove the lid and see if the vanilla can be smelled. Bring the jar close to the nose but do not touch the nose with the jar. If the vanilla can be smelled in jar No. 10, make further dilutions as in Step D until the vanilla cannot be smelled. If the vanilla is not smelled in jar No. 10, try Nos. 9, 8, 7, and so on. Mark down a + if anything is smelled and a - if there is no odor.

JAR NO.	OBSERVATION (+ or -)
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	

The point where the odor is first detected is called the *threshold*. Check the threshold of the students in the class. Does everyone have the same threshold? Chart the results.

F. Now calculate how many times the original

vanilla was diluted to get the threshold. Here is a sample calculation: To make the stock solution, the vanilla was diluted 1000 times. The No. 1 jar contains this stock solution; the No. 2 jar is diluted by a factor of 2; the No. 3 jar by another factor of 2; the No. 4 jar is a blank; the No. 5 jar has another factor of 2; and so on. If a student's threshold was found on jar No. 5 in Drawing 2, the amount of total dilution would be:

$$1000 \times 2 (\text{jar } 2) \times 2 (\text{jar } 3) \times 2 (\text{jar } 5) = 8000 \text{ or one part vanilla to } 8000 \text{ parts water}$$

(To obtain your threshold multiply by a factor of 2 each time you progress to the next jar, remembering that the blank samples are not used in computing the dilution factor.)

G. Find thresholds of some other materials such as oil of peppermint, oil of wintergreen, or some other food flavoring.

Applications

You have seen that activated carbon can be used to concentrate organic materials from water. Once these materials are concentrated, they can be removed from the carbon by extraction with solvents such as chloroform and alcohol. The solvents are distilled, leaving a residue. This residue represents the organic contaminants that were in a large volume of water. These contaminants may have been present in only one part in one million, or even one billion, parts of the water but they can cause taste and odor or interfere with water treatment. It is important to know if such materials in water affect health.

Chemists at the Robert A. Taft Sanitary Engineering Center recover and study organic contaminants as follows:

1. They develop methods for determining what kind and how much of the various materials are present in water.
2. They try to determine what materials cause water to taste or smell bad.
3. They study other damage caused by these contaminants such as interference with water treatment or damage to aquatic life.
4. They try to determine whether such materials in water can be harmful to humans.
5. Using the information gained from such studies, scientists are better able to maintain and control the quality of water for the nation.

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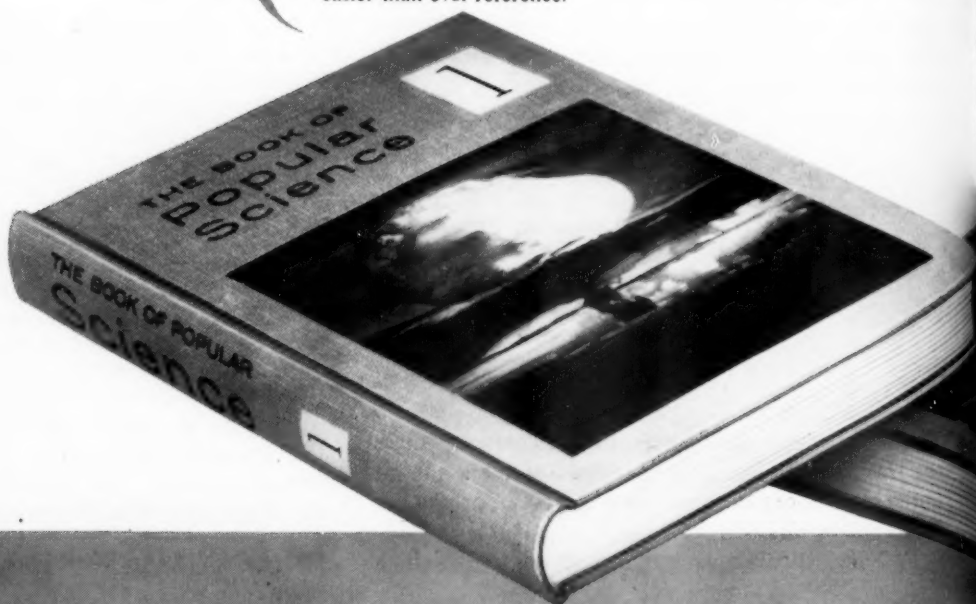
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Development of an Undergraduate Research Program

By JOHN G. ARNOLD, JR.

Chairman, Department of Medical Technology, Loyola University, New Orleans, Louisiana; Chairman, Committee on Undergraduate Research, Louisiana Heart Association, Inc.

IN SEPTEMBER 1953 the Research and Fellowship Committee of the Louisiana Heart Association, Inc., realizing that the heart problem had been made more critical because of the dearth of qualified research investigators in the field of cardiovascular disease, proposed a long-range program in an attempt to rectify this difficulty. It was the committee's desire to bring the importance and the necessity of cardiovascular research to the undergraduate level in the hope of developing interest in problems and techniques of research.

A representative group of science professors was invited to meet in October to discuss the feasibility of an undergraduate group undertaking or participating in a research program. As a result of the meeting, sponsored by the Louisiana Heart Association, a permanent Steering Committee was organized to conduct an undergraduate research program and a program was adopted. The Steering Committee, composed of interested representatives from the undergraduate science departments of the various approved Louisiana colleges and universities, supervises and evaluates the program annually. It makes recommendations for subsequent activity to the Louisiana Heart Association.

From the membership of the Steering Committee a five-member Research Project Committee was elected. It meets twice a year, April and November, to process applications for project support during the summer and fall semesters. The recommendations are presented for disposition to the Research and Fellowship Committee of the Louisiana Heart Association. The general form of the application and the policy for grants-in-aid are the same as used by the American Heart Association, Inc.

Certain guidelines are followed when project requests are considered by the Research Project Committee:

1. The development of research methods and techniques is considered of primary importance; publication of the undergraduate project results is secondary.
2. Research projects are recommended as substitutes for certain problem courses now offered in some schools.

3. Efforts are made to stimulate the work of chemists and biologists, even more than that of premedical students, to create interest in the basic science approach to future cardiovascular research.

Ten of the 24 accredited Louisiana universities and colleges have been approved for at least one research project each, for a total of 19 projects. Five schools have had research projects rejected because they were improperly presented or prepared, or appeared to be beyond the scope or capabilities of undergraduate students.

To conduct the approved research projects, 33 students have been accredited. These students were accepted either as the principal investigators, collaborating investigators, or as replacements for either category. Only three students have failed to work on or complete their projects.

By early 1957 the financial expenditures for the program for the 19 projects totalled \$3945.43. The approved project expenditures ranged from \$30 to \$500.

The undergraduate research program of the Louisiana Heart Association has been brought before and kept before the public eye of the community by several activities.

1. Several of the project results have been reported by the students themselves before the collegiate section of the combined annual meetings of the Louisiana Academy of Sciences and the New Orleans Academy of Sciences.* This policy not only informs the public of the work which is being done by undergraduates, but gives the students themselves invaluable training in the preparation and presentation of scientific data.
2. The members of the Steering Committee have participated on several occasions in round-table discussions concerning the activities and the value of the undergraduate research program of the Louisiana Heart Association.
3. A Speakers Bureau for the undergraduate research program was formed. The speakers present the facts of the program to civic and professional groups.
4. Annually the Louisiana Heart Association Com-

* Okin, Robert, 1956. "Catch Them Young." *The American Heart*. 6:7

mittee on Undergraduate Research, parent group of the Steering Committee, sponsors an open-house program at the medical schools of Tulane University and Louisiana State University and the dental school of Loyola University. All three institutions are located in New Orleans. Major research programs are shown and explained to students of Louisiana universities and colleges visiting at these sessions.

5. In order to bring home the importance as well as existence of an undergraduate research program, the Louisiana Heart Association presented a large disarticulated heart model to all the colleges and universities of the State of Louisiana. These models were presented to the individual schools at a convocation, where the purpose and objectives of the program were explained to the student body.
6. In order to maintain lasting recognition for the undergraduate research program, all of the materials awarded to the schools receiving research grants-in-aid are properly labelled with decals stating the source of the equipment.

Conclusions

Research on the undergraduate level is now a proven and successful fact. In 1953 it was the hope of the parent Research and Fellowship Committee and the Committee on Undergraduate Research of the Louisiana Heart Association to influence one or more students to enter the research field during the program's first years of existence. Not only has the quality of the work accomplished surpassed the highest hopes of the members of the committee but the activities and vocations of the recipients of the grants far exceed expectations. A breakdown of these follows:

1. Seven recipients have entered into medical studies (St. Louis University Medical School, Stritch Medical School, Louisiana State University Medical School).
2. One recipient matriculated in the dental school of Baylor University.
3. Six recipients have entered or have become staff members of graduate schools (four at Louisiana State University and two at Tulane University).
4. One recipient transferred to the field of science education.
5. Thirteen have graduated from, interned in, or become registered in the field of medical technology.
6. One recipient biology graduate is now a field representative for a pharmaceutical supply company.
7. One recipient joined the staff of the Southern Regional Laboratory of the United States Department of Agriculture.

The Louisiana Heart Association has experienced real satisfaction with the results of this pioneering

effort in the field of undergraduate research. It feels that the future in this field is still fertile, especially for giving research activities stature in the eyes of young people, particularly in communities which do not sponsor medical or professional schools. The Louisiana Heart Association is grateful for the encouragement received from national groups, and for the fact that additional professional groups, including the American Association for the Advancement of Science, are undertaking or sponsoring undergraduate research programs.



As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to TST's calendar editor. Space limitations prevent listings of state and local meetings.

June 25-27, 1958: American Association of Physics Teachers, Boulder, Colorado

June 27-28, 1958: NSTA Annual Summer Meeting with the National Education Association, The Ohio State University, Columbus

June 30-July 4, 1958: National Education Association Annual Meeting, Cleveland, Ohio

August 18-20, 1958: 18th Summer Meeting, National Council of Teachers of Mathematics, Colorado State College, Greeley

September 7-12, 1958: 134th National Meeting, American Chemical Society, Chicago, Illinois

October 17-18, 1958: NSTA Southeast Regional Meeting, Nashville, Tennessee

October 17-18, 1958: NSTA Southwest Regional Meeting, Pasadena, California

November 27-29, 1958: 58th Convention, Central Association of Science and Mathematics Teachers, Indianapolis, Indiana

December 27-30, 1958: NSTA Annual Winter Meeting with science teaching societies affiliated with the American Association for the Advancement of Science, Washington, D. C.

April 1-4, 1959: NSTA Seventh National Convention, Atlantic City, New Jersey

Pressure Areas in the Classroom

By ARTHUR J. GIOVANNANGELI

Professor of Science, Keene, New Hampshire, Teachers College

Readiness concepts in the use of the aid, "Pressure Areas." The following concepts are fundamental for the teaching of understanding of the action of weather instruments.

An isobar is a continuous line drawn through places (weather reporting stations) of equal pressure.

A "High" or high pressure area is represented by a sequence of closed lines in which the barometer readings of the isobars increase as the center approaches. It is called a High or high pressure area because the barometer is highest at the center. The cold dry air at the center of this area is descending and, upon coming in contact with the earth's surface, fans out in all directions. Since heavier air has less heat than lighter air, the molecules are closer together and thus the air has less space, allowing fewer water vapor molecules to be diffused between the air molecules. The fact that the air molecules are closer together and contain a small amount of water vapor results in lower temperature and fair weather clouds or no clouds—clear cool weather.

An understanding of the comparable characteristics of the "Low" or low pressure area: barometer reads lowest in the center, air is rising and converging at the center of the pressure area, air is warmer and the molecules are further apart, thus having more space for the diffusion of water vapor molecules, resulting in hot humid weather.

Uses of the Air: Pressure Areas

Teaching understandings of the action of weather instruments. Sample questions by the teacher, and pupil answers which are delimited, if necessary, by the guidance of the teacher are found below. The use of the weather instruments by the pupils or teacher at the appropriate time will give realism to the situation. Sample questions and answers:

1. What happens to the barometer as the first stage of the pressure area (see diagram) passes over Keene?* Barometer falls.

2. What happens to the thermometer? Because of the hot humid mass of air approaching, the thermometer rises.

3. What direction will the wind vane indicate?

*Keene, New Hampshire, where the author developed and uses this teaching technique in weather education.

Because of our relative position to the center of this pressure area and the air converging and ascending at the center, the wind vane will show an east wind.

Move the pressure areas chart to the next stage and use the same or similar questions as in the above procedure. Use the same technique for the remaining stages until they have all been analyzed with the weather instruments.

Evaluating understandings of the action of weather instruments. Using the pressure areas chart, slide the chart to the right so that the first stage is over the town. Ask the students: As this stage of the pressure area passes over Keene, what action or change, if any, will the instruments indicate? Sample test items follow:

Multiple Choice Items

Barometer: (1) rise (2) fall (3) highest (4) lowest

Thermometer: (1) rise (2) fall (3) highest (4) lowest

Wind vane: (1) north (2) east (3) south (4) west (5) calm

Move the pressure areas chart to stage number 2 and repeat the same questions. Continue this, completing the six stages.

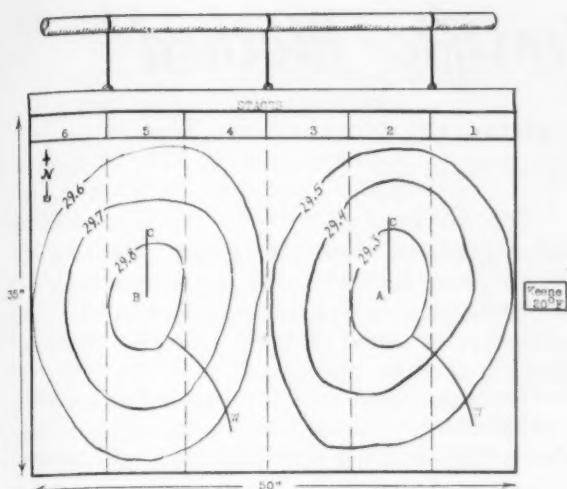
Now move the pressure areas chart to stage number 2 and ask the students to describe the sky condition over Keene at that location.

Next move the teaching aid so that stage number 5 is over Keene and ask the students: What is the character of the sky condition over Keene at this location?

Samples of completion-type test items: At what stage or stages are you most likely to have precipitation?..... What type? Why?

Describing the Teaching Aid

Construction and description of the aid. Using a thick type of cellophane or plastic transparent material about 50 inches long and 35 inches wide, draw three heavy oval-shaped closed lines, representing isobars, for a low pressure area, as in the diagram. The diagram should require about half of the cellophane. Do the same on the other half of the cellophane, except number the isobars to



The author's diagram of the pressure areas teaching aid.

represent a high pressure area. With dotted lines running up and down or north and south, separate the two pressure areas into a total of six stages or sections as in the diagram. Mark the centers of the pressure areas "A" and "B." Draw two lines in each pressure area: The curved line from the center isobar extends downward and beyond the furthest isobar in that pressure area and a straight line from the center of the pressure area up to the mid-distance between the first and second isobars. Letter these "W" and "C" respectively. Finally, mark the top of the chart North. Fasten a broom handle or dowel to the top of the cellophane so that the chart will hang flat in front of the blackboard and can be moved from left to right as it rests on a tray support.

Localizing the problem. In using this aid, the problem can be localized by printing the name of the town or city on the blackboard to the right and center of the pressure areas chart. The printed name of the town should not be any larger than the width of the "stage." For effect, one might sketch a barometer, wind vane, and thermometer near the name of the town. Finally, give the thermometer a temperature reading.

Activities to Use With the Aid

Basic activities. Some basic activities to be used with the teaching aid follow.

1. On the curved lines marked "W" in the diagram, place arrows showing wind direction.
2. On the straight lines marked "C" in the diagram, place arrows showing air currents.
3. What type air pressure area is "A?" "B?"
4. Which pressure area will move into the

region occupied by the other pressure area? Explain.

5. How would the readings of the weather instruments compare in the stages if the northern sections of the pressure areas pass through Keene?

6. For an eight hour period, at intervals of two hours, have the pupils record actual readings of the barometer, wind vane, thermometer, and sky condition. Using the barometric readings, draw isobars. Based on the above information, place Keene in its relative vertical position in the pressure area passing over. The following day obtain a weather map from a newspaper and compare the pressure area or areas with the instrument readings constructed and developed by the class the previous day. Have the class discuss: Are there any major differences? Can we account for these differences? How?

7. Explain the scientific operating principle of the weather vane, thermometer, barometer, and hygrometer.

8. What are the characteristics of the following clouds: cirrus, cumulus, stratus, and nimbus—as to size, shape, height, and color?

9. What conditions are necessary for the formation of the following types of precipitation: rain, snow, hail, sleet, dew, frost, and glaze?

Related activities. Some related activities to be used providing for individual differences of pupils in the use of this aid are found below.

1. What action or change, if any, will the hygrometer indicate as the stages of the pressure areas pass over Keene? Can the hygrometer be used to measure relative humidity if the temperature is below zero? Explain.

2. Draw a low pressure area using the following barometric readings: 29.7, 29.6, 29.8, and 29.5. Write the barometric readings on the isobars.

3. How do scientists explain the origin and development of high and low pressure areas?

4. What is the average size and velocity of pressure areas over the United States?

5. Why do Air Corps weather observers study the "eye" of the hurricane?

6. What pressure areas are found at the poles? Equator? Explain.

7. Why is it difficult to forecast the weather? How accurate is the Weather Bureau's forecast?

8. Why do planetary winds shift in latitude during the year?

9. Name the different types of Weather Bureau stations and give the duties of each. What data must each collect? When must it be collected?

10. What is the origin of the prevailing westerlies? Why do they move toward the northeast?

Functional Scientific Method

By EDWARD W. STEFANIAK

Johnson, Vermont, Teachers College

THE VALUE OF LEARNING A PRINCIPLE lies, to a great degree, in being able to apply it to meaningful situations. Practice in the use of what has been learned consists of practice in the use of deductive reasoning. This can be taught at an early age, and elements of the scientific method, inductive and deductive, should be taught in the elementary school as well as at the high school and college levels.

The scientific method, as we generally know it, is the inductive method. In its simplest form, it is characterized by generalizing from results pointing to a conclusion. For example, one arrives at the generalization that metals conduct electricity by placing objects made of different materials across a gap in a series circuit. In a similar manner it is found that, in general, nonmetals do not conduct electricity.

There are several steps in the inductive method: sensing a problem, defining the problem, suggestions for possible solutions, analysis of solutions, experimentation and/or gathering data, analysis of results, arriving at conclusions, and generalizing.

The method is much more effective if one more step is added. What is needed is the application of the generalization to specific cases. In other words, the deductive method should be employed.

The process is simple, consisting only of adding an examination phase to the inductive method. In the example above, all one needs to do is to apply what has been learned to other substances which have not been tested. Students decide whether things like nickel, mercury, silver, silk, plastic, or gold will conduct electricity by applying the principle that metals conduct electricity. They may also determine the reasons for the use of different materials in electrical wiring, batteries, and appliances.

This might be done by discussing the uses of such substances as nichrome, German silver, copper, aluminum, mica, carbon, rubber, cotton, glass, and shellac. Household appliances, insulators, insulated wire, fuses, and electricians' gloves may be used. Pupils will probably see a relationship between the use of the material in the field of electricity and the experiment on conductivity. However, they should be encouraged to withhold

conclusions until they have enough evidence to be sure. This evidence can be gathered through experimentation, observation, reading, directly from authority, or from all these sources. However, guessing must be discouraged.

I recently found that a great proportion of a class of college students knew the kinetic molecular theory but could not apply it. They explained it perfectly, and then went on to say that a gallon of warm water weighs more than a gallon of cold water because water expands when it is heated. After pupils learn principles of flotation, many of them state that ice and cream are heavier than water and milk even though they know both float. These examples, and others, indicate that teaching the generalization is not enough. There must be practice in the application of this principle to specific cases until it becomes a matter of routine for the student to think of application.

The inductive method alone is too limited. It does not teach the application of the principle, thus confining the learning, for many students, to the facts as observed. By applying the generalization to specific cases, greater advantage can be taken of the student potential for independent thought, research activities, and inventiveness.

Laboratory work should precede classroom recitation. The laboratory is of little value if it degenerates to the point where students perform experiments to find out what they already know. This is the case when classroom recitation precedes laboratory work. The laboratory should be a research center, a place where students discover principles and learn the laws of science. The student needs to have the type of directions which will lead him to experiment, observe, record, discover, and draw conclusions. The nature of the laboratory makes it imperative that he make several trials and arrive at conclusions. There should be enough trials to make it possible for the student to generalize, and he should be encouraged to make application of the principle learned. This application may be a statement of the practical use of it or it might be the analysis of a problem in the laboratory involving the same principle.

Science should provide stimulation of the mind to the extent that a greater number of pupils will

carry their activities beyond the classroom, preferably on a voluntary basis. Many will do this if motivated sufficiently, and one way to motivate is to make the principle meaningful.

What is true of science is true of other areas of learning. Pupils know principles of mathematics, but cannot solve problems. Formulas can be developed by the inductive method and the application to problem solving can be taught by the deductive method. Too many pupils memorize formulas without knowing how they are derived. Therefore, they cannot use them when circumstances demand.

Pupils should develop formulas through a reasoning process. This can be done as follows: Suppose we wish to find how much interest we would have to pay on a bank loan of \$200 for one year at 5%. Pupils know that they have to pay interest and that they pay it yearly. If \$200 is borrowed for 5% for one year, they can readily see that the interest (I) is $\$200 \times .05 \times 1$ or \$10. Several problems can be done and in the course of solving them the words Principal (P), Rate (R), and Time (T) introduced. If pupils are taught to substitute letters for numbers they will arrive

at the formula $I = P \times R \times T$ inductively. This is a much better procedure than finding a formula at the top of a page, and the application phase will be much more meaningful.

Practice in generalizing from a set of grouped or ungrouped data is valuable at all age levels. Children can learn to generalize when learning their multiplication facts:

$9 \times 1 = 9$	$9 \times 6 = 54$
$9 \times 2 = 18$	$9 \times 7 = 63$
$9 \times 3 = 27$	$9 \times 8 = 72$
$9 \times 4 = 36$	$9 \times 9 = 81$
$9 \times 5 = 45$	$9 \times 10 = 90$

The following generalizations can be made:

1. The sum of the digits is 9 in each case.
2. The units digit decreases by 1 when 9 is multiplied by each succeeding higher number.
3. The tens digit increases by 1 when 9 is multiplied by each succeeding higher number.

The application of these generalizations is found in the pupil multiplying by 9. He can be taught to realize that he can never get 32, 33, 34, 35, 37, 38, or 39 when he multiplies 4 by 9.

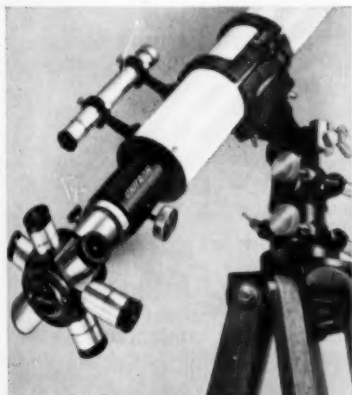
Mathematics students can generalize from

THE SKY IS THE LIMIT

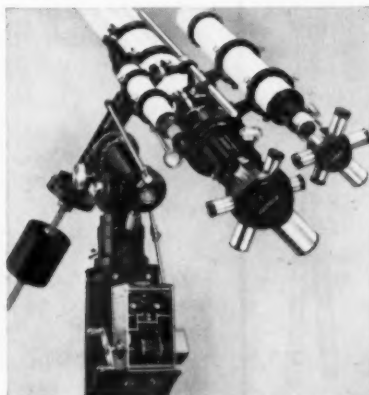
The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age". Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.

In teaching, there is a compelling need to give students an opportunity to do more than just read about the universe.

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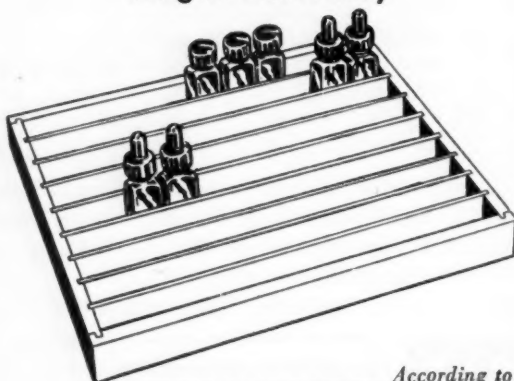
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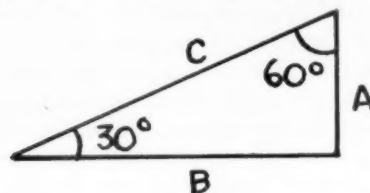
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grouped data in a manner similar to the following involving a 30-60 degree right triangle:



a	b	c
1	1.732	2
2	3.414	4
3	5.196	6
4	6.928	8
5	8.660	10
6	10.392	12

These students should be led to discover that the relationship between the three sides of this particular type of triangle is 1, $\sqrt{3}$, and 2.

Problems involving 30-60 degree right triangles can be solved by the application of this relationship to problems.

Most of the rules of grammar and punctuation can be taught in a similar manner and their use in speaking and writing taught by the deductive method. By observing them day after day and having the teacher call them to their attention, children learn certain facts. They learn to stop at periods, to put periods at the end of sentences; that sentences begin with capital letters, that they start names with capitals, that capitals are used to begin names of cities, states, and countries. Finally, after they have observed these usages many times, they make rules for their use. The application comes in the use in assigned work.

For example, this method can be used to learn a rule for contractions:

haven't	(have not)
weren't	(were not)
doesn't	(does not)
I've	(I have)
I'll	(I will)

Pupils will make the rule that apostrophes are used in place of one or more letters when two words are combined to form a contraction. As a result, the rule will be meaningful and contractions will be used much more correctly.

The fact that we can improve on the use of the principles we learn in all courses of school instruction is generally recognized. Much can be done by using the inductive approach to develop generalizations, formulas, and rules as needed, and the deductive to apply them to specific situations. This is a Functional Scientific Method.

N · S · T · A LIFE MEMBERS

With 78 names added since the last announcement in *TST* (May 1957), the NSTA Life Member roster was just under the 400 mark as of April 21, 1958. The gain of nearly 80 members within the past year is a particularly impressive one in the light of the increase in Life Membership cost as of July 1, 1957—from \$100 to \$175 if paid in ten annual installments or \$150 if paid in three years or less. This membership gain is indicative of the stature of NSTA in the science teaching profession and, along with it, of the teacher's appreciation of the added services and distinction that come with Life Membership.

Following are the year's 78 new Life Members:

ALBER, GROVER B., Detroit, Michigan
ALFKE, DOROTHY, State College, Pennsylvania
ANDREWS, OLIVER A., Green Bay, Wisconsin
ANSPAUGH, ROBERT E., Evanston, Illinois
ASKWITH, JERRY, Washington, D. C.

BABCOCK, MRS. CHARLOTTE, Albany, Oregon
BASSETT, ROBERT D., Manhasset, New York
BIAGIOTTI, MARIO J., New York, New York
BISHOP, MARY RUTH, Kingsport, Tennessee
BLACKWOOD, PAUL E., Washington, D. C.
BRECKENRIDGE, JOHN W., Montrose, Kansas
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BYINGTON, FRED D., Redlands, California

CARONE, JOHN EDWARD, Brooklyn, New York
CARROLL, FRANCIS R., Spokane, Washington
CLARK, DONALD L., French Lick, Indiana
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DEYOUNG, MARVIN, Edgerton, Minnesota
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GOINS, WILLIAM F., JR., Brooklyn, New York
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RUSSELL, EMERSON, Syracuse, New York

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Elementary Science Suggestions

By WILLIAM PAUL MOSER

Director of Elementary Education, New Albany-Floyd County Consolidated School Corporation, New Albany, Indiana

Editor's Note: Recently I came into possession of a "Dear Parents" note that was sent home with the kindergarten children. It said: "We wanted to have some baby chicks. Mr. — made an incubator for us. He used a box and light bulbs. We got six eggs and five hatched. One night the incubator got too hot and three died. We put the other two in a bucket. They went to the bathroom on the floor because they were afraid . . ." More about how cute and fluffy they were, etc.

Reading this made me realize again the tremendous job we face in helping elementary teachers understand what kind of science is appropriate for young children—and in learning how to teach it so that it is science.

At about the same time as the incident above, I also came into possession of several issues of *Science Suggestions*, a regular mimeographed publication of the New Albany (Indiana) elementary schools. How the New Albany plan works is the subject of this article which, coincidentally, includes directions from one issue of *Science Suggestions* (Vol. II, No. 2) on making an incubator.

Robert H. Carleton

IT IS OUR BELIEF that one of the needs in elementary science, besides that of helping the teacher gain background and experience in science, is the need of communication. Our elementary system is just about ideal in size—16 schools and 160 teachers. Each school has a full-time supervising principal. With this kind of favorable setup, it seemed incumbent upon us to look for answers to our needs.

To help improve the situation, I called a meeting of teachers interested in science, one from each school. At this meeting we formed into a committee and selected a chairman who was delegated responsibility for the direction of the committee's efforts.

The assignment to each member of the committee was to observe the science program in his school. When he finds something particularly interesting going on in any of the classrooms, he checks with the teacher in charge, gets the details, and submits a written report to the chairman. The chairman edits this and forwards the article to my office. I, in turn, submit the paper to our art department for illustration purposes.

When the science report is returned, I check to see that the teacher is given credit for his or her work. Then the report is mimeographed for distribution

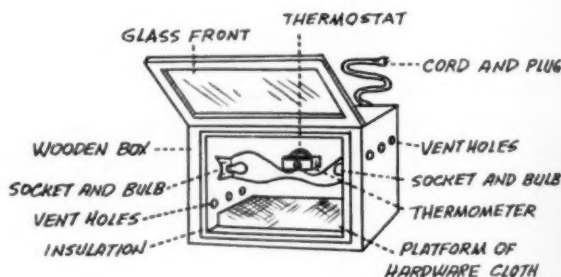
under the title of *Science Suggestions*. We have been distributing these *Science Suggestions* at the rate of one every two weeks. We try to maintain a balance of content and grade level. The plan has been working fine for three years and really has not been a big task.

We also recognize the need for communication with the community as well as among ourselves. To accomplish this, we have provided each committee member with a number of blanks that request data on possible photographs in his or her school. When these forms are returned and evaluated favorably, one of us here at the curriculum center goes to the school, takes photographs, and prepares an article for the local paper.

I think our community realizes we are teaching science.

The following piece on construction of an incubator is an example of the content of *Science Suggestions*.

How to Construct an Incubator



You will need:

A sturdy wooden box 10" wide, 10" high, and 15" long, the box to be open on one side.

A pane of glass 10" wide and 15" long to cover the open side of the box.

A thermostatic switch suitable for an incubator. This may be obtained from hardware stores anywhere or from Sears, Roebuck and Company (Farmaster Automatic Temperature Control), Model 595.405 (approximate cost \$3.00).

One incubator thermometer suitable for either brooder or incubator. This, too, may be purchased at a hardware store.

Two Bakelite or porcelain standard receptacle sockets to hold light bulbs.

Two electric lamps—preferably 15 watts each—to serve as heaters.

Two electric attachment plugs.

One piece of hardware cloth about 12" wide and 18" long to support no more than 12 eggs.

One large cake pan about 8" wide and 12" long to hold water under hardware cloth.

Enough Celotex, beaverboard, or other insulating material to line the inside of the incubator.

Miscellaneous nails, bolts, tape, paint, and so on for use in the construction.

To construct the incubator:

- Nail the insulation inside the box.
- Bore holes for ventilation and for the thermostat.
- Screw or bolt the sockets and the thermostat inside the box.
- Wire the sockets to a plug for attachment to the thermostat. The wires may be stapled out of the way along the top or back of the box.
- Bind the glass front with adhesive or Scotch tape. Use two strips of adhesive tape about 1½ inches wide to form a double-thickness flap along the top edge. Tack this flap along the top edge of the box to hinge the glass front.

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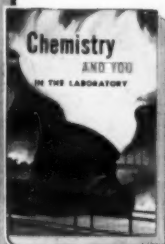
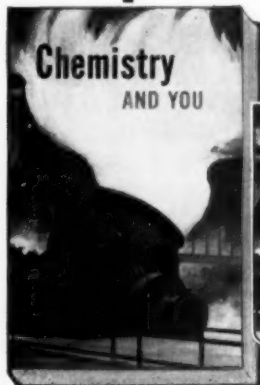
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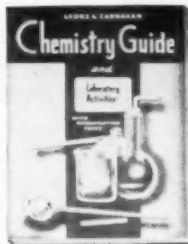
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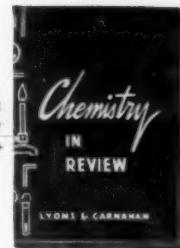


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SPROUTING FOR SPROUTS

By WILLIAM O. TUOMINEN

Harrison Technical High School, Chicago, Illinois

VERY OFTEN a student's only experience with scientific experiment takes place in the school laboratory. Need this be the case?

The answer should be a definite, "No." There are countless experiments or problems which can be conducted safely and with the ordinary equipment found around the home. Why not assign a problem to the budding young scientist in lieu of his regular "homework?"

We have had considerable success with a number of "take home" problems in our biology classes. Here is one of the more successful ones. All the student needs to start him off on his scientific adventure is a packet or two of radish or pea seeds, some old dinner plates, and a large piece of blotting paper or a piece of flannel cloth.

The student's problem is to determine the percentage of germination of the seeds. In order to solve the problem, he must utilize the methods and attitudes of the scientist; that is, he must recognize a problem, understand the problem, collect facts, organize, experiment, and draw conclusions.

The teacher can arouse interest in the problem by passing out packets of radish seeds to the students, first making certain that the percentage of germination figures are stamped on the packets. Someone is sure to ask about the figure. At this point, start a class discussion centering around the establishment of the figure. Many students may seem confused when asked how they would determine the percentage figure. If no bright student ventures a tentative answer, the teacher then establishes a formula. We have used the following formula:

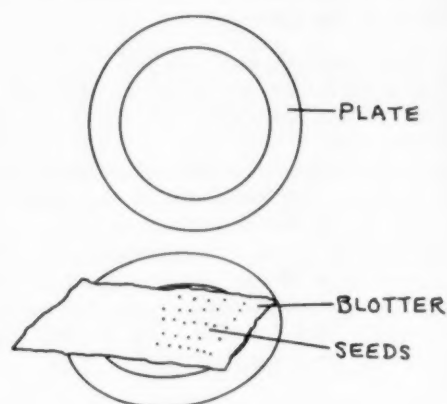
$$\frac{\text{Number germinated}}{\text{Number of seeds}} = \text{A decimal} \times 100 = \% \text{ germination}$$

EXAMPLE:

$$\frac{80 \text{ (germinated)}}{100 \text{ (original)}} = .80 \times 100 = 80\% \text{ germination}$$

Once the formula is clearly established and understood, begin a discussion on possible ways to germinate seeds. We use ordinary dinner plates and blotting paper, although there are many other ways to germinate seeds. A strip of blotting paper, 6 inches wide and 12 inches long, is wetted thoroughly, folded, and then reopened. One-half of the

wet paper is placed upon one of the plates. Then the carefully counted seeds are placed on the paper, the other half folded over, and the other plate put over the whole. This combination makes an excellent moist chamber suitable for germination.



At this point, considerable enthusiasm is usually generated for the project. We ask for volunteers to do the project at home. The entire class could do the experiment at home, and at a later date compare data and results. Also, the students need not be restricted to only pea and radish seeds. Some of our students have checked as many as 60 different kinds with some amazing results. Some seeds will not germinate because of their hard coats; for some the temperature range is not favorable; and for yet others, different factors are responsible.

Two restrictions are placed on the home experimentation: the students must write their experiments down in formal scientific fashion and they must have their data organized. A simple box, such as illustrated, will help them keep their figures organized.

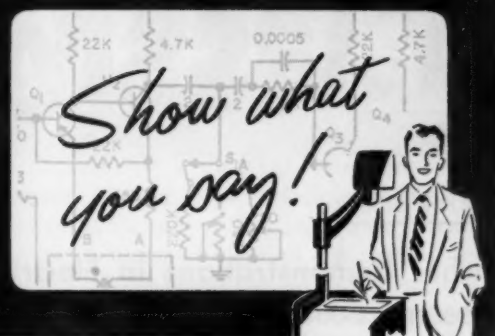
Seed	No. of seeds	Number germinated	%
Pea			
Radish			
Etc.			

In about a week, the students bring in their data

and experiments. Most students have poorly developed powers of observation, although their germination figures will be fairly accurate. We follow up with a series of questions which prompt a new appraisal of their experimentation and a sharpening of their powers of observation. Types of questions which can be asked are: Why didn't all of the seeds germinate? How did you know when germination was complete for all of the seeds? Did you examine the coats? Why is your percentage germination figure different from that of others?

Our experience has been that students are enthusiastic about home experimentation. We attribute this enthusiasm to the fact that most children are naturally curious and love to experiment. It remains only for the teacher to tap this natural bent and lead it into useful channels. There are many, many experiments that are adaptable to this type of treatment. We find it quite useful to have a file of such experiments on hand to meet the needs of the bright, the curious, and those students who enjoy home experimentation. Two conditions must be borne in mind; namely, the experiment must be safe and the materials must be readily available in the home. We find that when students must bother the corner druggist or some other source, this acts as a deterrent to the completion of the experiment.

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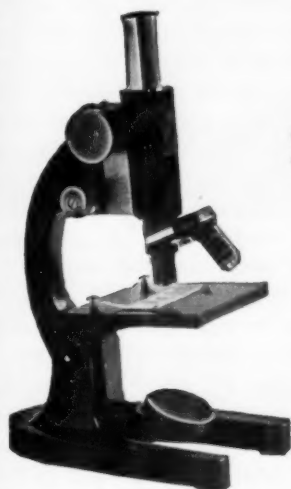


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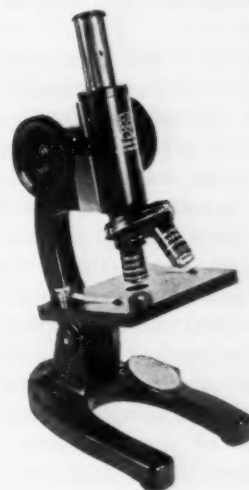
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Classroom Ideas

General Science

Teacher Demonstrations in Electricity

By ROBERT L. BRANDENBURG, Science Department,
Alva, Oklahoma, High School

This Classroom Idea was one of the entries submitted in the 1956-57 STAR (Science Teacher Achievement Recognition) awards program.

The types of demonstrations explained here are especially adapted to the classroom teacher who finds himself with too many students and too little space and equipment. In discussing electricity and how it is used with general science students, nothing would be better than for the individual student to have a complete set of electrical equipment and be able to set up his own experiments and demonstrations of the material being studied under the supervision of the instructor. However, when this is impossible due to the shortage of equipment and space, the instructor must resort to the next best method of motivating the students and obtaining the best possible learning situation. This, of course, will be the teacher demonstration so organized that each student will receive an equal amount of practical application. I believe the method of demonstration described here is both practical and beneficial.

Some of the important phases of electricity that should be demonstrated to the students are series and parallel circuits, operation of doorbells and buzzers, action of different types of switches, carbon arc lamp, voltmeters, and ammeters. If the teacher has to assemble these materials each day and then put them away at the end of the class period, much valuable instructional time has been wasted. It will not be wasted if the demonstration material is organized as a complete instructional unit.

The method I am using is to mount all of this demonstration material on a portable panel that may be displayed in an upright position at the front of the classroom in full view of all the students. The first step in developing this method is to decide how much demonstration material is to be used (this can be overdone) and where it is to be mounted on the panel.

An ideal way of laying out this material is to make a scale drawing of the panel with the exact location of each piece of apparatus. One of the primary things to consider at this time is the location of the power supply, whether it be a transformer or dry cell batteries or both. I believe the transformer to be the more convenient. It must be located in such a position as to provide electricity to all of the appliances in the easiest manner. The two output leads of the transformer then should lead to a junction box and be connected to a set of switches so that the current may be directed to whatever appliances the instructor is going to demonstrate. This not only focuses the attention of the students, but also acts as a safety factor. As another safety precaution, the panel should operate on low voltage.

To demonstrate series and parallel circuits, four or five lamps are arranged in the proper order using cleat receptacles as bases. The wire used should be a stiff, bare wire located so that it is plainly visible to the students and they may see the path that the electric current must follow. By unscrewing one or two lamps, it can be demonstrated how the addition or elimination of resistances will affect the rest of the circuit. Instead of unscrewing the lamps, one or two switches may be placed in the circuit to vary the resistance.

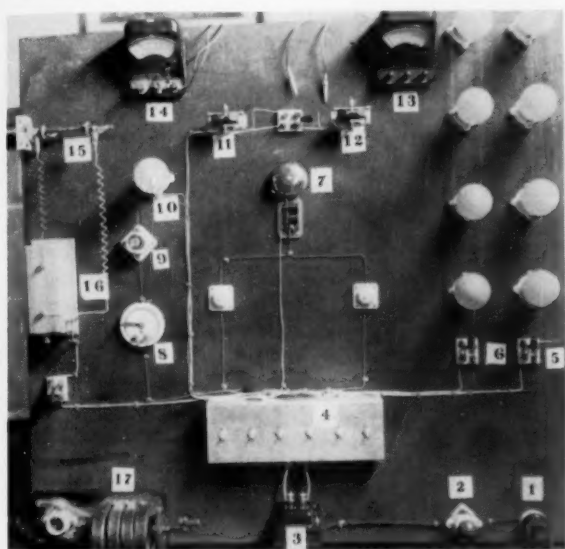
To illustrate how a doorbell may be rung from either a switch at the front door or one at the back door, two pushbutton switches and a buzzer are arranged in parallel so that either switch will operate the buzzer independently of the other.

To emphasize the value of safety fuses in the home, a rheostat, a low-voltage fuse, and an ammeter are arranged so that the students can read the strength of current flowing through the circuit. The current can be varied enough by the rheostat to cause the fuse to blow. To make the demonstration more impressive, the wire in the circuit may be hooked up to cause a short circuit that will blow the fuse before the wire becomes overheated. The relationship of short circuits and fires in the home can be pointed out.

To demonstrate electric motors, a St. Louis motor would be preferable; however, a toy motor may be used, especially if it is one that has been assembled

by a group of students. The motor should be situated so that the instructor can easily point out the important parts of the motor and the path of the electricity through the motor. Also, all of the wiring leading to the motor will be in full view and the students can easily see the points where the current enters and leaves the motor.

Another easily obtainable and practical piece of demonstration equipment is the telephone generator. This may be mounted so that it can be connected to any of the equipment on the panel. Two binding posts can be installed on the panel so that students may "get the feel" of electricity. I have always found it interesting to the students to have them form a circle holding hands and let the current flow through several of them while someone slowly turns the generator.



1. Master control switch. 2. Red light shows current is to transformer. 3. Six-volt transformer. 4. Control panel: directs current to different appliances. 5. Series circuit. 6. Parallel circuit. 7. Doorbell with two pushbutton switches. 8. Rheostat. 9. Fuse. 10. Resistance to blow fuse. 11. Motor. 12. Motor—switch in between to control operation of second motor. 13. Ammeter. 14. Voltmeter with test leads attached. 15. Carbon arc lamp. 16. Induction coil. 17. Telephone generator. Total cost of panel: \$12.51.

As a climax for the unit on electricity and also to stimulate further interest in electricity, the carbon arc lamp may be demonstrated. Even though some textbooks never mention the carbon arc lamp, I have found it to be a very stimulating demonstration. This equipment, too, is mounted on the demonstration panel with the necessary switches and induction coil. In demonstrating this lamp the instructor should point out the space between the carbon tips and what is actually happening. The tremendous amount of heat between the two

points may be illustrated by placing different objects such as paper and thin strips of wood between the two points to show how readily they burst into flames.

The demonstrations described here are ones that I have used and have mounted on my demonstration panel. Other instructors may choose different equipment or a different arrangement of the equipment, but the basic principle of the method used remains the same. The panel may be enlarged each year as new and different equipment becomes available. I have found this method so satisfactory that I also have made a demonstration panel for weather equipment to be used specifically when studying weather; however, I have mounted this panel permanently in the classroom. I find that the students are always interested in such weather information as the speed of the wind, relative humidity, barometric pressure, and temperature.

Physics

The Use of Dry Ice in Heat Transfer Experiments

By JAMES ATTISON McCLANAHAN, Poca, West Virginia, High School

Our classes in physics have been using an interesting variation of the usual methods for determining specific heats of metals and coefficients of linear expansion of 60-cm metal rods.

Instead of using steam to heat the metals, we use dry ice to cool them. To find the specific of copper we weighed out 300 g of copper, packed it in dry ice, and left it there overnight. The temperature of the copper when used was -79°C . We used an aluminum calorimeter of thermal capacity of 13.7 containing 186.3 g of water. The copper was quickly transferred from the dry-ice pack to the calorimeter. The changes in temperature of copper and water were measured and the specific heat calculated. Specific values obtained for copper and several other metals measured in this way were found to be approximately the same as values obtained by the "hot method" of heat transfer experiments.

By use of dry ice we were able to measure the specific heat of ice and the heat of fusion of mercury.

To find the coefficient of thermal expansion of a 60-cm brass rod, we pack the tube containing the rod with dry ice that has been well crushed. The linear expansion apparatus is then set for a zero

reading that will allow as much expansion indicator room as the scale provides. The apparatus remains as set until the dry ice evaporates and the tube and rod have risen to room temperature. The increase is then read on the scale and the tube from a steam generator is connected to the tube containing the brass rod. When the rod has been heated to 100° C, a final length increase reading is taken. From the data obtained in this experiment three slightly varying values of the coefficient of thermal expansion of brass can be calculated.

Experiments like these may encourage students to seek new methods in scientific experimental work. If they seek new methods, they may find better ones.

Biology

A Simple Demonstration of the Bacteriostatic Effect of Antibiotics

By LEONA K. ADLER, Hunter College High School, New York City

This article was submitted as an entry in the 1956-57 STAR (Science Teachers Achievement Recognition) awards program.

The effect of antibiotics on the growth of bacteria can be simply and effectively demonstrated by applying a procedure frequently used in medical diagnostic laboratories. Sensitivity discs, used in this procedure, are antibiotic tablets of standardized strength. They are prepared by several pharmaceutical companies. Pathologists use them to determine, *in vitro*, which antibiotics will be most effective in treating a particular bacterial infection in a patient.

Sensitivity discs are usually purchased in sets. A set consists of a number of different kinds of antibiotic tablets, such as penicillin, aureomycin, terramycin, chloromycetin, etc. The tablets are of uniform strength and each has a number imprinted on it, 1, 2, 3, 4, etc., corresponding to a particular antibiotic. A key to these numbers is provided with the set.

Blood agar is usually used as the medium for the test in diagnostic laboratories because pathogenic organisms are being tested. In the classroom, however, ordinary nutrient (meat extract) agar can be used. The test can be applied to either known or unknown organisms.

The materials needed are:

- (1) a culture of bacteria to be tested
- (2) several sterile Petri dishes containing sterile nutrient agar
- (3) several sterile swabs (Q-tips will do)
- (4) a set of sensitivity discs

The following procedure is used:

(1) Prepare a culture of bacteria using any of the standard bacteriological methods.

(2) Lightly rub a sterile swab on a colony of bacteria so that the bacteria are slightly dispersed on the swab. This can be done by touching the colony lightly and twisting the swab very slightly.

(3) Inoculate the entire surface of a sterile agar plate as evenly as possible by rubbing the swab lightly back and forth across the surface of the agar. (Figure 2)

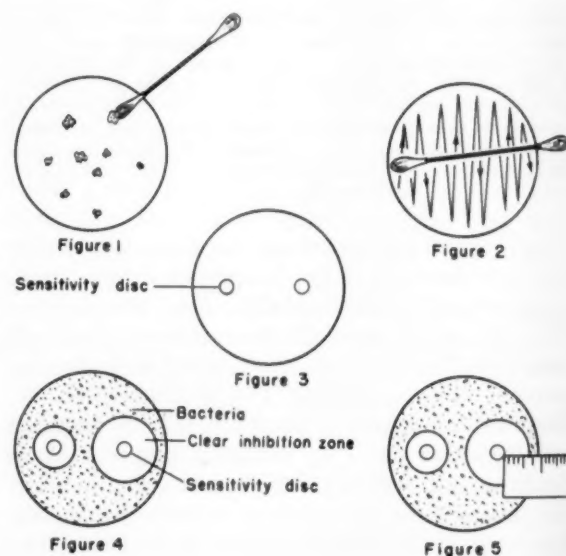
(4) Place one or two sensitivity discs on the surface of the agar. (Use forceps.) Space the discs in such a way that the inhibition zones around them will not interfere with each other.

(5) Incubate for 48 hours, but *examine after 24 and 48 hours*. (You will probably see a result after 24 hours.)

(6) After incubation an inhibition zone will be clearly seen around each tablet. A definite circle around each tablet will be clear, while the rest of the surface will be covered by a growth of bacteria. The radius of the circle around each tablet should then be measured with a ruler. Since this will be clearly visible through the bottom of the Petri dish, the measurement is more easily made by inverting the dish and measuring on the outside, through the glass. (Figure 5)

The procedure outlined above is so simple and

Figure 1. A colony of bacteria is gently picked up by the swab. Figure 2. The swab is moved lightly back and forth across the surface of a sterile agar plate. Figure 3. Sensitivity discs are placed on the surface of freshly inoculated agar. Figure 4. Result after incubation (24 to 48 hours). Figure 5. The inhibition zone is measured through the bottom of the Petri dish.



requires so little bacteriological technique that it makes an interesting laboratory exercise for the students as well as a startling demonstration. The comparative effect of different antibiotics on the same or on different bacteria can be quantitatively determined by measuring the inhibition zones and comparing them.

On a more simple level, this demonstration can be used to illustrate one of the most dramatic moments in the history of science—Sir Alexander Fleming's accidental discovery of the area of clearing surrounding the mold which contaminated his bacterial culture—a discovery that revolutionized the treatment of communicable disease.

Additional Notes

1. The sensitivity discs I use are called "Dia-Discs." They are prepared by: Reed & Carnrick, 155 Van Wagener Avenue, Jersey City 6, New Jersey. Sensitivity discs are also prepared by other pharmaceutical companies, such as Squibb, Lederle, Pfizer, etc.
2. The formula for nutrient agar used in these experiments is as follows:

Agar	15g or 1.5%
Peptone	10g or 1.0%
Meat extract	3g or 0.3%
Sodium chloride	5g or 0.5%
Water	1000 ml

Physics

Archimedes' Principle—An Exception?

By F. MERRY, Leigh Central County Secondary School, Lancashire, England

The usual statement in textbooks is somewhat as follows:

"When a body is wholly or partially immersed in a fluid the apparent loss of weight is equal to the weight of fluid displaced."

Can a body then float in a liquid whose weight is LESS than that of the floating body?

Obtain two cooking bowls, one of which fits inside the other. Pyrex bowls (2-pint size and 3-pint size) work very well.

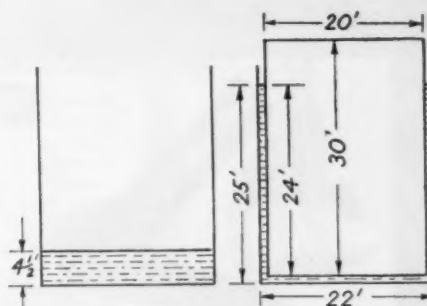
Experiment. Weigh the smaller bowl. Put into larger bowl an amount of water less than the weight of smaller bowl. See if the smaller bowl will float.

Weight of floating body = 780 g

Weight of water = 190 g

Here the apparent loss of weight (780 g) is more than the weight of liquid displaced since the floating body can only displace, at the most, 190 g.

Consider a "ship" in the shape of a rectangular prism, say 40 ft. long by 20 ft. wide by 30 ft. deep. This is floating in a rectangular "dock" with, say, 1 ft. clearance all round, up to a depth of, say 24 ft.



Volume of water (cubic feet) =

$$(42 \times 22 \times 25) - (40 \times 20 \times 24) = 3,900 \text{ cu. ft.}$$

When "ship" is out of "dock" this water would occupy the "dock" to a depth of

$$\begin{aligned} & 3,900 \div (42 \times 22) \text{ ft.} \\ & = 3,900 \div 924 \text{ ft.} \\ & = \text{less than } 4\frac{1}{2} \text{ ft.} \end{aligned}$$

Therefore this "ship" could float in $4\frac{1}{2}$ ft. of water.

Since the "ship" floats with 24 ft. of its 30 ft. submerged its S. G. = 0.8.

\therefore Weight of ship

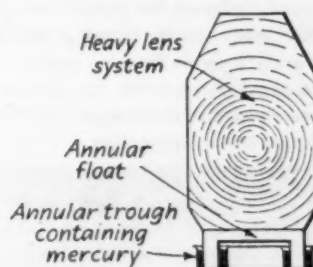
$$\begin{aligned} & = 40 \times 20 \times 30 \times 0.8 \times 62.3 \text{ lb.} \\ & = 535 \text{ tons approx.} \end{aligned}$$

$$\begin{aligned} \text{Weight of water in dock} & = 3,900 \times 62.3 \text{ lb.} \\ & = 110 \text{ tons approx.} \end{aligned}$$

Weight of water displaced

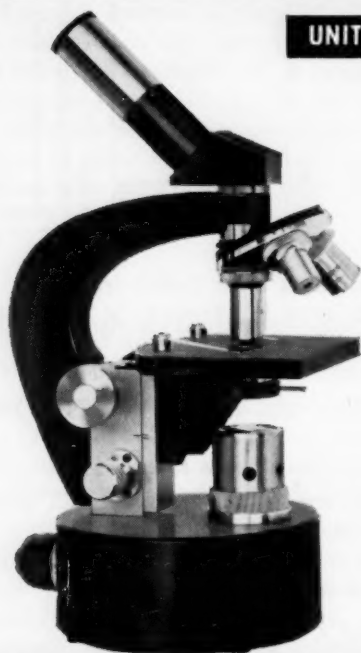
$$\begin{aligned} & = (3,900 - 42 \times 22) \times 62.3 \text{ lb.} \\ & = 2,976 \times 62.3 \text{ lb.} \\ & = 83 \text{ tons approx.} \end{aligned}$$

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1958 Winners

Science Achievement Awards for Students

Representing projects developed both before and after the beginning of the satellite age, the entries in this year's—the 7th annual—program of Science Achievement Awards for Students covered virtually every field of science. Osmosis, shells, gibberellic acid, Einstein's theory of relativity, and marine biology were project subjects along with entries on radioactivity, rockets, telescopes, and metal structures. Considering the variety and scope of the entries, the judges concluded that there is a wealth of students from whom will come the future scientists of America and that their professional interests will show not only in the more spectacular scientific phases being nurtured by the space age but in the basic sciences as well.

Conducted by the Future Scientists of America Foundation of the National Science Teachers Association, the program was again sponsored this year by the American Society for Metals. This financial support by ASM—for the seventh successive year—marks a noteworthy and foresighted contribution to America's future science security.

The awards are made in two groups. The first are the 20 National Metals Awards—\$100 U.S. Savings Bonds each—for projects dealing with metals and metallurgy and judged on a national basis. There are also 120 awards judged on a regional basis at grade levels in eight geographic regions. In each region, 15 entries were selected as winners: five 7th- and 8th-grade students received \$25 Savings Bonds; five 9th- and 10th-grade students received \$50 Savings Bonds; and five 11th- and 12th-grade students received \$75 Savings Bonds. The metals and metallurgy projects were included in the regional judging before being submitted for the national awards.

The awards winners also received FSA gold lapel pins and FSA certificates. Their schools are being sent FSA trophy case plaques engraved with the names of the winning students. Honorable Mention certificates were given to 1673 entrants in recognition of the calibre of their work.

Guidelines for the 1958 program were established by the following Advisory Committee: N. C. Fick, Commodity Industry Analyst, Office of Defense Mobilization, Washington, D. C.; Veryl Schult, Supervisor of Mathematics, Washington, D. C., Schools; Willard Schumaker, Principal, Kensington, Maryland, Junior High School; Ruth C. Strosnider, Biology Teacher, Woodrow Wilson High School, Washington, D. C.; and Robert H. Carleton, NSTA Executive Secretary.

The following list includes the names of all students who won National Metals and Regional Awards. The student's name is followed by grade, project title,

school, and name of teacher sponsor. While the supply lasts, a complete list, including students who won Honorable Mention, is available at the NSTA office.

NATIONAL METALS AWARDS

- Behrs, John O.** (12): *Large Scale Separation of the Rare Earth Elements*; Palo Alto Sr. H. S., Cal. **Henry C. Martin.**
- Dillard, David Pierce** (12): *A Cooling Curve Study of Non-ferrous Metals and Alloy Combinations*; Muskegon Sr. H. S., Mich. **Douglas Tool.**
- Erickson, Robert** (12): *Edge Effects in Metal Plating*; Cathedral Boy's H. S., Springfield, Ill. **Rev. Arnold Perham.**
- Fairburn, H. A. Alden** (12): *Mechanism of Failure of Rocket Materials*; Lorain H. S., Ohio. **Harold Freshwater.**
- Fantazier, Richard** (12): *Single Crystals of Austenite Stainless Steel*; St. Thomas H. S., Braddock, Pa. **Sister Ignatia Marie.**
- Garrett, Jack** (10): *Crystallization by Hydrogen of Metal Halides*; University School, Columbus, Ohio. **Irwin Slesnick.**
- Heiner, Anthony** (9): *Coefficient of Linear Expansion in Metals*; Bennington Catholic H. S., Vt. **Sister Mary Cephus.**
- Hume, Alfred** (11): *Making Aluminum Castings*; West H. S., Knoxville, Tenn. **James Hardin.**
- Kelly, Peter A.** (11): *Aluminum*; John F. Deering H. S., West Warwick, R. I. **John Kelly.**
- Koh, Robert** (12): *Bonding of Silver Brazed Stainless Steel Joints*; Tarentum H. S., Pa. **Lester Edinger.**
- McLaughlin, Robert** (9): *A Study of Metal Whisker Growth*; Samuel Hamilton Jr. H. S., Pittsburgh, Pa. **Dorothy Grob.**
- Motzer, Jean** (12): *Kymographic Recordings of the Expansion of Metals*; Leadville H. S., Colo. **Leonard H. Pratt.**
- Nevels, James** (9): *Mineralogy: A Must for Metallurgists*; St. Joseph School, Norman, Okla. **Sister Charles Ann.**
- Nininger, Neil** (12): *The Production of High Temperature Tantalum Carbide Filaments*; Tamalpais H. S., Mill Valley, Cal. **Raymond Palmer.**
- Owen, Bruce M.** (9): *Comparison of Metal Structures*; Millbury Memorial H. S., Mass. **Thomas McGinn.**
- Pellicori, Sam** (12): *The Growth of Crystalline Solids in a Magnetic Field*; Mary D. Bradford School, Kenosha, Wis. **Mary A. Doherty.**
- Schultz, Richard** (9): *Ceramic Coating of Aluminum*; St. Thomas H. S., Braddock, Pa. **Sister Ignatia Marie.**
- Shapiro, Devrie** (12): *The Effect of Surface Tension Variations upon the Rates of Corrosion of Various Metals in an Aqueous Solution of Radioactive Salts*; Great Neck H. S., N. Y. **Lewis Love.**
- Siegel, Melvin** (12): *Powdered Fuel for Oxyhydrogen Torch*; Stuyvesant H. S., New York, N. Y. **Nathan Marks.**
- Tietz, Henry** (12): *Influence of Argon on Copper and Aluminum at High Temperatures*; Central H. S., Tulsa, Okla. **George W. Hall.**

REGIONAL AWARDS

Region I

(Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)

Chairman, **Howard E. Norris**, The Loomis School, Windsor, Connecticut

GRADES 7-8

Carroll, Sue (8): *Einstein's Theory of Relativity*; Coolidge Jr. H. S., Natick, Mass. **John A. Lucas**.

Kelly, Colleen (7): *Components of Air*; West Warwick Jr. H. S., R. I. **Gilda Martone**.

Meyer, Richard (8): *Model Rocket Engine Thrust and Impulse*; Sumner Smith School, Lincoln, Mass. **David Webster**.

Sperry, Arthur (8): *The Development of a Sensitive Vibration Indicating System*; Weston H. S., Mass. **Dorothy Mulroy**.

Williams, Thomas (7): *How a Computer Works*; Sumner Smith School, Lincoln, Mass. **David Webster**.

GRADES 9-10

Booth, Gregory S. (9): *Osmosis and Osmotic Pressure*; Middlebrook Jr. H. S., Trumbull, Conn. **Thomas W. McCann**.

Owen, Bruce M. (9): *Comparison of Metal Structures*; Millbury Memorial H. S., Mass. **Thomas McGinn**.

Teller, Patricia (9): *Periodic Precipitates in Silica Gel*; Middlebrook Jr. H. S., Trumbull, Conn. **Earle C. Sullivan**.

Wisner, George (10): *A New Method of Stereophonic Sound Reproduction*; Bulkeley H. S., Hartford, Conn. **Mahlon Hayden**.

Wodecki, Katherine (10): *A Fundamental Operation of Numbers in the Various Bases*; Cathedral H. S., Hartford, Conn. **Sister Mary Justin**.

GRADES 11-12

Goldberg, Alfred L. (11): *Electrical Activity in Vision*; Classical H. S., Providence, R. I. **John Lafferty**.

Kelly, Thomas (11): *Microbiological Studies on the Metabolic Mechanism of 4-Aminomethylpteroylglutamic Acid and Nucleic Acid Metabolism*; Weston H. S., Mass. **Wallace W. Sawyer**.

Morin, Mary (12): *Cancer Chemotherapy*; St. Joseph H. S., Manchester, N. H. **Sister Mary Beatrice**.

Nathanson, Robert (12): *A Strain Survey to Determine Susceptibility to Acute Disseminated Encephalomyelitis in Jackson Laboratory Mice*; William Hall H. S., West Hartford, Conn. **John Prymak**.

Reissner, John E. (11): *Preliminary Investigations in the Effects of Tranquilizers on Conditioned Behavior Patterns in Mice*; Weston H. S., Mass. **Wallace W. Sawyer**.

Region II

(New Jersey, New York, Pennsylvania)

Chairman, **Richard F. Mason**, Madison, New Jersey, High School

GRADES 7-8

DeMauro, Patricia (8): *Hydroponics*; Canastota Central School, N. Y. **Genevieve Lamp**.

Dritz, Kenny (8): *Demonstrational Binary Computer*; Hartsdale Jr. H. S., N. Y. **Gilbert Brown**.

Goell, Martha (8): *Test Tube Tadpoles*; Quaker Ridge School, Scarsdale, N. Y. **Nathan Sloan**.

Naison, Mark (7): *Combination Light-Meter Metronome*; Winthrop Jr. H. S., Brooklyn, N. Y. **George Fishbein**.

Strom, Robert (7): *Syllogistic Analyzer*; Jr. H. S. 82, Bronx, N. Y. **Rose Haibloom**.

GRADES 9-10

Hunt, David (10): *Applications of Short Ultraviolet Radiation*; Irvington H. S., N. J. **Maitland P. Simmons**.

McLaughlin, Robert (9): *A Study of Metal Whisker Growth*; Samuel Hamilton Jr. H. S., Pittsburgh, Pa. **Dorothy Grob**.

O'Hare, Michael (10): *Digestion in Paramecium*; Bronx H. S. of Science, N. Y. **Paul Kahn**.

Sorkin, Judith (9): *What Effect Does X-ray Irradiation Have upon Regeneration in Planaria?*; Jr. H. S. 171, Brooklyn, N. Y. **Solomon Feldman**.

Ziesse, Norman (9): *Electromagnetism and Transformer Action*; Collingswood Jr. H. S., N. J. **Patricia Degelman**.

GRADES 11-12

Benrey, Ronald (12): *Project Argus*; Bronx H. S. of Science, N. Y. **Herman Gewirtz**.

Downing, Diane E. (12): *Experimentations on a Neurophysiological Stain*; Kenmore Sr. H. S., N. Y. **Louise Schwabe**.

Rintel, Joan (12): *A Study of the Head Canal System in the Genus Xiphophorus*; Forest Hills H. S., N. Y. **George Schwartz**.

Siegel, Melvin (12): *Powdered Fuel for Oxyhydrogen Torch*; Stuyvesant H. S., New York, N. Y. **Nathan Marks**.

Strom, Stephen (11): *An Automatic Photoelectric Tracking Device for Telescopes*; Bronx H. S. of Science, N. Y. **Herman Gewirtz**.

The only "repeater" as a National Metals Awards winner in the 1957 and 1958 SAA programs, Richard Fantazier, of St. Thomas High School, Braddock, Pennsylvania, is seen here receiving his 1957 FSAF certificate from NSTA representative Dorothy Grob. Richard's teacher-sponsor, both last year and this, is Sister Ignatia Marie. He graduates from high school this spring. Miss Grob, who teaches at Samuel Hamilton Junior High School, Pittsburgh, Pennsylvania, was herself sponsor of another of this year's National Metals Awards winners—Robert McLaughlin, a ninth-grade student.



Region III

(Delaware, District of Columbia, Kentucky, Maryland, North Carolina, Tennessee, Virginia, West Virginia)
Chairman, **Donald C. Martin**, Physics Department, Marshall College, Huntington, West Virginia

GRADES 7-8

- Brelick, Susan** (8): *Decalcification of Bone*; North Bethesda Jr. H. S., Bethesda, Md. **Doris E. Hadary**.
Brynes, Edward (8): *Some Independent Research on the Three-Bar Linkage and Its Curves*; Woodward School for Boys, Washington, D. C. **Milenko I. Phillips**.
Fraze, Candy (7): *Corrosion of Metals*; Alice Deal Jr. H. S., Washington, D. C. **Betty Schaaf**.
Hunt, John C. (7): *Homemade Computer*; Alice Deal Jr. H. S., Washington, D. C. **Betty Schaaf**.
Martin, James (8): *Plant Hormone Experiments*; North Bethesda Jr. H. S., Bethesda, Md. **Doris E. Hadary**.

GRADES 9-10

- Burslem, William** (9): *An Experimental Evaluation of an Anticancer Drug*; Hyattsville Jr. H. S., Md. **George Higgs**.
Halverstott, Richard (9): *A Study of Hospital Staphylococcus Aureus*; Hart Jr. H. S., Washington, D. C. **Mabel Duvall**.
Miller, John (10): *Effects of Gibberellin on Pollination*; Kenwood H. S., Baltimore, Md. **Byron Kadel**.
Minor, Edward (10): *The Effects of Alternating Current or Alternating Audio-Frequency Magnetic Fields on Paramcium*; Baltimore City College, Md. **Edward Sellmayer**.
Schooley, Robert (10): *Natural Radioactivity in the Air*; Anacostia H. S., Washington, D. C. **Samuel Fishkin**.

GRADES 11-12

- Ganz, Edward** (11): *An Electronic Logic Analyzer for Solving Problems in Propositional Calculus*; Walter Johnson H. S., Rockville, Md. **Allan Harrison**.
Grimm, Frank W. (11): *Distribution of Land Snails in Maryland*; Catonsville H. S., Md. **Frances E. Davidson**.
Mallette, Vincent (12): *Electrical Combination Lock*; McCallie Preparatory School, Chattanooga, Tenn. **Paul Greer**.
Weiskittel, Harvey (11): *Tack, A New Dominant Lethal in Drosophila Melanogaster*; Kenwood H. S., Baltimore, Md. **Byron Kadel**.
Yearwood, Kenneth (12): *Miniature Explosions*; David Lipscomb School, Nashville, Tenn. **John Netterville**.

Region IV

(Alabama, Arkansas, Canal Zone, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, South Carolina)
Chairman, **Ernest E. Snyder**, State Teachers College, Florence, Alabama

GRADES 7-8

- Brown, Willie** (8): *A Comparative Study of Leaf Pigments in Selected Plants*; Jackson State College Lab. School, Jackson, Miss. **Anna Wilson**.
Carson, Christopher (7): *A Study of the Vitamin C Content of Various Foods*; Horace Mann School, Miami, Fla. **Harriet Ehrhard**.
Coleman, Alvin (8): *Low Melting Point Alloys and Some of Their Physical Characteristics*; Jackson State College Lab. School, Jackson, Miss. **Anna Wilson**.

Heard, Rhefeldtnette (7): *Comparative Adaptations in the Digestive System of the Frog, Turtle, and Bird*; Jackson State College Lab. School, Jackson, Miss. **Anna Wilson**.
McCune, Patsy (7): *Leguminous Plants and Root Nodule Bacteria*; Jackson State College Lab. School, Jackson, Miss. **Anna Wilson**.

GRADES 9-10

- Hosford, Mike** (9): *A Study of the Bacteria Found in Different Types of Milk and Water*; Northside H. S., Atlanta, Ga. **Julia Newton**.
Minkin, Anne (10): *A Statistical Study of Background Radiation*; Grady H. S., Atlanta, Ga. **Rufus Godwin**.
Norell, Russell (10): *The Interaction of Light and Matter When the Latter Is Subjected to an Electric or Magnetic Force*; North Miami Sr. H. S., Fla. **Harold Quincy**.
Rhoads, Patricia (9): *What Is Subconscious Advertising?*; Northside H. S., Atlanta, Ga. **Lois Boardman**.
Whitener, Ginny (9): *Ossification of the Tadpole's Skeleton*; Miller Jr. H. S., Macon, Ga. **Ruby Tanner**.

GRADES 11-12

- Delcher, Harry** (12): *Methods of Chromatography*; Hillsborough H. S., Tampa, Fla. **Marina Reby**.
Grillo, Jose (12): *Alkaloids of Puerto Rico*; Notre Dame H. S., Caguas, Puerto Rico. **Sister M. Natalie**.
Pickron, Robert N. (12): *Elementary Crystallography*; Hillsborough H. S., Tampa, Fla. **Marina Reby**.
Spence, Keith (11): *Eight-Inch Reflector Telescope*; Biloxi H. S., Miss. **Della McCaughan**.
Williams, Sarah (11): *The Remarkable Recuperative Powers of Planaria*; Northwestern H. S., Miami, Fla. **Gwendolyn Barnett**.

Region V

(Illinois, Indiana, Michigan, Ohio)
Chairman, **Richard W. Schulz**, Physics Department, Purdue University, Lafayette, Indiana

GRADES 7-8

- d'Azevedo, Anya** (8): *The Liberation of the Hand*; Haven Jr. H. S., Evanston, Ill. **Steve Hall**.
Harris, Jim (7): *Electrolysis*; Sharp Corner School, Skokie, Ill. **Elizabeth Hall**.
Johnson, Jim (7): *Florida Shells*; Haven Jr. H. S., Evanston, Ill. **Alfred Lazow**.
Peterson, Douglas (8): *A Model of a Fishery*; Haven Jr. H. S., Evanston, Ill. **Alfred Lazow**.
Sanderson, Christopher (7): *Study of the Embryological Development of Chick Eggs*; Haven Jr. H. S., Evanston, Ill. **Alfred Lazow**.

GRADES 9-10

- Bates, Richard S.** (9): *Development and Significance of Critical Transformation Points for Two Steels*; West Lafayette Sr. H. S., Ind. **Kenneth Bush**.
Garrett, Jack (10): *Crystallization by Hydrogen of Metal Halides*; University School, Columbus, Ohio. **Irwin Slesnick**.
Herkner, David W. (10): *Embryo Gallus Domesticus*; University School, Shaker Heights, Ohio. **John R. Baker**.
Settle, Wayne L. (9): *Radiation, A Tool in Plant Breeding*; Portland Wayne Twp. H. S., Portland, Ind. **Ralph D. Settle**.
Stern, Donald (10): *The Effects of D-Lysergic Acid Diethyla-*

vide (LDS) on Maze Learning in the Siamese Fighting Fish; Shaker Heights H. S., Ohio. **Jack Miller.**

GRADES 11-12

- Hahne, Marjorie** (12): *A Statistical Analysis of Fossil Species*; Evanston Twp. H. S., Ill. **Murl B. Sailsbury.**
Kreutzig, Kirk (12): *Fish Do Talk*; Evanston Twp. H. S., Ill. **Guenther Kolb.**
Schoch, Karen Margaret (11): *Chromatography*; Lyons Twp. H. S., LaGrange, Ill. **Robert L. Walker.**
Settle, Eileen Jane (12): *Insects on 160 Acres*; Portland Wayne Twp. H. S., Portland, Ind. **Ralph D. Settle.**
Spitzer, Robert H. (12): *Electrophoresis and Its Applications in Inorganic Analysis*; University of Detroit H. S., Detroit, Mich. **Rev. Raymond J. Feurstein.**

Region VI

(Canada, Iowa, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, Wyoming)
 Chairman, **James A. Rutledge**, Teachers College, University of Nebraska, Lincoln

GRADES 7-8

- Busse, Wally** (8): *Solar Furnace*; U. S. Grant School, Sheboygan, Wis. **Walter Lartz.**
Schaefer, John (8): *Electricity versus Bacteria*; U. S. Grant School, Sheboygan, Wis. **Walter Lartz.**
Walthers, Wendy (8): *How Can Ink Be Removed from Newspaper?*; U. S. Grant School, Sheboygan, Wis. **Walter Lartz.**
Williams, Gerald (8): *Making a Telescope*; Manly Public School, Iowa. **Lillian Neu.**
Yonke, Ronald (8): *Making Pulp and Paper from Vegetable Fibers Other than Wood*; Wausau Jr. H. S., Wis. **Amos Yonke.**

GRADES 9-10

- Bush, David** (9): *A Study of the Effects of Gibberellin on Various Plants*; Visitation H. S., Stacyville, Iowa. **Sister Marianne.**
Hulick, Tim (10): *Combination Electrocardiograph and Electroencephalograph*; Aquinas H. S., LaCrosse, Wis. **Sister Paula Marie.**
Jahnke, Philip (9): *The Effects of Phenylhydrazine and Urethane on the Growth of the Ascities Tumor*; Ramsey Jr. H. S., Minneapolis, Minn. **Donald D. Bevis.**
Maradik, Marilyn (10): *Natural Dyes from Plants*; Notre Dame H. S., Milwaukee, Wis. **Sister Mary Natalia.**
Wilson, Mary Sue (9): *Antibiotic Effect of Various Commercial Products*; Teachers College H. S., Cedar Falls, Iowa. **Walter Gohman.**

GRADES 11-12

- Andersen, Roger** (12): *On Inducing Polyploidy in Fragaria Ovalis*; Great Falls H. S., Mont. **Gertrude Olson.**
Gollnick, Daniel (12): *An Experimental Method of Determining Neutron Cross Sections*; Central Sr. H. S., LaCrosse, Wis. **Ole Oines.**
Koop, LaMonte (12): *The Biological Effects of X rays*; St. Boniface H. S., Cold Spring, Minn. **Sister Bernice.**
Martin, Stephen H. (12): *The Effect of pH on the Contraction of Isolated Smooth Muscle*; Alexander Ramsey H. S., St. Paul, Minn. **Theodore Molitor.**
Pellicori, Sam (12): *The Growth of Crystalline Solids in a Magnetic Field*; Mary D. Bradford H. S., Kenosha, Wis. **Mary A. Doherty.**

Region VII

(Colorado, Kansas, Missouri, New Mexico, Oklahoma, Texas)

Chairman, **Paul A. Wilkinson**, Manual High School, Denver, Colorado

GRADES 7-8

- Alpha, Sigma** (8): *Earth Structural Patterns as Simulated by a Stress Box*; Wheat Ridge Jr. H. S., Colo. **William D. White.**
Boone, Nick (8): *Texas Marine Biology*; Pershing Jr. H. S., Houston, Tex. **Mae Beth Moses.**
Clay, Henry (8): *Miniature Wind Tunnel*; Norman Jr. H. S., Okla. **T. H. Tucker.**
Jones, Gwyneth (8): *A Study of Acceleration*; McKinley Jr. H. S., Albuquerque, N. M. **David M. Dennis.**
Wender, Joe (8): *Types of Paper Chromatography*; Norman Jr. H. S., Okla. **T. H. Tucker.**

GRADES 9-10

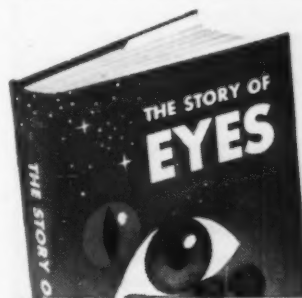
- Baca, Gene** (10): *Variation of Reaction Time*; Leadville H. S., Colo. **Leonard H. Pratt.**
Broemmer, Richard H. (9): *Cobalt-60 Absorption*; Garfield Jr. H. S., Albuquerque, N. M. **Herbert H. Wigley.**
Siebert, Charles (10): *Effect of Gibberellic Acid in Nutrient Media*; Christian Brothers School, St. Louis, Mo. **Brother Josephus.**
Triplett, Baylor (9): *The Problems and Solution Encountered in Designing and Building a Cosmic Ray Research Vehicle*; Jefferson Jr. H. S., Albuquerque, N. M. **David M. Dennis.**

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Wideman, C. D. (10): *Two Molds*; Brentwood H. S., Mo. Charles Duggan.

GRADES 11-12

Amman, Lorraine (12): *Airport Surveillance Radar*; Pueblo Catholic H. S., Colo. Sister Georgianna.

Fearing, Harold (12): *The Determination of the Charge of an Electron*; Lawrence H. S., Kan. Garvin C. Gillum.

Frank, Robert (12): *My Scientific Project on Ornithology*; Norman H. S., Okla. Vivla Johnson.

Logan, Barrie (12): *Isolation of a New Growth Stimulant*; Stephen F. Austin H. S., Austin, Tex. Edna Boon.

Remple, Robert Keith (11): *A Comparison of Hypothermia Produced by Two Tranquilizing Drugs*; Lawrence H. S., Kan. Garvin C. Gillum.

Region VIII

(Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, Utah, Washington)

* Chairman, Gertrude W. Cavins, San Jose, California, State College

GRADES 7-8

Fuller, Pamela (8): *Atomic Energy in Plant Nutrition*; Doolen Jr. H. S., Tucson, Ariz. Kenneth Torgerson.

Golding, Steve (8): *The Isolation and Examination of Microorganisms*; Doolen Jr. H. S., Tucson, Ariz. Arnold Kelm.

Movitt, John (7): *Gasoline Mixture*; Piedmont H. S., Cal. Jerome Benson.

Shetter, Andrew (8): *The Photography of Microorganisms*; Doolen Jr. H. S., Tucson, Ariz. Arnold Kelm.

Wright, John (8): *Deviation of the Compass Caused by Iron*; Santa Barbara Jr. H. S., Cal. Ivan Evans.

GRADES 9-10

Jones, Stanley (9): *Gibberellic Acid*; Gresham Union H. S., Ore. Irma Greisel.

Keizer, Joel (10): *Antibiotic Properties of Penicillium Roqueforti*; Beaverton Union H. S., Ore. Kathryn D. Ward.

Leuterio, Fria (10): *Effects of Gibberellins on Plants and Animals*; Mercy H. S., San Francisco, Cal. Sister Mary Lois.

Rhiger, David (10): *The Essential Chemical Elements of Plant Nutrition*; Beaverton Union H. S., Ore. Kathryn D. Ward.

Van Bruggen, Philip (10): *Radioautography*; Beaverton Union H. S., Ore. Kathryn D. Ward.

GRADES 11-12

Behars, John O. (12): *Large Scale Separation of the Rare Earth Elements*; Palo Alto Sr. H. S., Cal. Henry C. Martin.

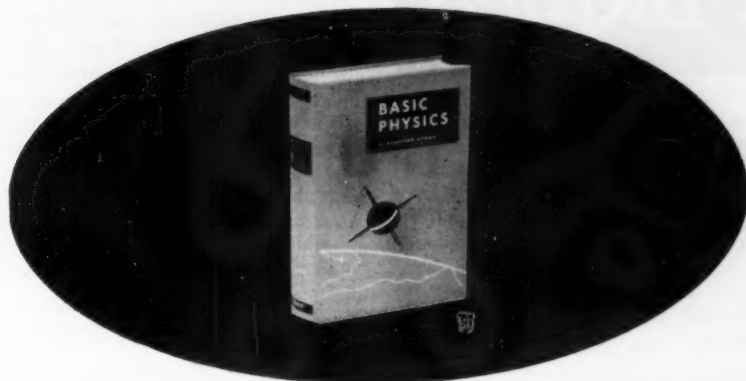
Brown, Robert (12): *The Extraction of Uranium Metal from Carnotite*; Washington H. S., Portland, Ore. David Porter.

Hardy, John (12): *Pituitrin Toxicology*; Claremont Sr. H. S., Cal. George Turner.

Metcalf, Lenda (12): *The Separation of Complex Organic Compounds by Three-Dimensional Electrophoresis*; West H. S., Phoenix, Ariz. Thomas Thorpe.

Simmons, Robert (12): *Synergism with Reference to Antimicrobial Substances*; Albany H. S., Cal. Mauri Gould.

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BOOK BRIEFS

HIGH SCHOOL PHYSICS, Revised Edition. Oswald H. Blackwood, Wilmer B. Herron, and William C. Kelly. 808p. \$5.20. Ginn and Company, Boston. 1958.

Updated revision of a popular text, presenting the principles and applications of physics clearly and in simple language. Scope of material provides learning and problem activities for students at different levels of interest and ability. Profusely illustrated, often in color, with photographs, drawings, diagrams.

SATELLITES AND SPACEFLIGHT. Eric Burgess. 159p. \$3.95. The Macmillan Company, New York. 1958.

Particularly timely scientific account of development of earth satellites, including details on construction, instrumentation, launching procedure, transmission of data, flight orbit. Also considers possibilities of manned rockets, manned space stations, and moon and planet expeditions.

SCIENCE IN DAILY LIFE, New Edition. Francis D. Curtis and George Greisen Mallinson. 580p. \$4.48. Ginn and Company, Boston. 1958.

Up-to-date revision of a basic textbook in general science, designed to serve the growing science interests of today's boys and girls. Innumerable illustrations in black and white, color.

BIOLOGY—THE LIVING WORLD. Francis D. Curtis and John Urban. 705p. \$4.96. Ginn and Company, Boston. 1958.

Handsomely illustrated new text for secondary schools, developed with objective of providing essentials of biology

for the large majority of students who take only the one-year course. Also provides satisfactory foundation and training for advanced work. Reading comprehension a strong point.

SCIENTISTS' CHOICE: A Portfolio of Photographs in Science. Franklyn M. Branley, Editor. \$4.95. Basic Books, Inc., New York. Publication date, June 5, 1958.

Collection of 12 stunning photographs well worth framing in the classroom or library, with handsome eight-page brochure giving photographic and scientific explanation for each. Convincing proof of the value of the camera in science and how it aids in the search for truth. Photographs were selected and are described by leading scientists. Portfolio also includes a guide booklet for the amateur photographer, "Using Your Camera in Science."

SECOND-RATE BRAINS. Kermit Lansner, Editor. 96p. \$1.50. Doubleday News Book, Doubleday and Company, New York. 1958.

Paperback collection of articles by top scientists, educators, journalists answering such queries as: Are Russians Super-Robots? and Are We Educating for Extinction? Authors include recommendations as well as survey of situation.

STRANGE PLANTS AND THEIR WAYS. Ross E. Hutchins. 96p. \$2.95. Rand McNally and Company, Chicago. 1958.

Handsomely illustrated (black and white) report on various cannibal and vampire plants, slime mold, and other strange and unusual kinds of plant life. Vivid word description, too, which is attention-holding.

INTRODUCTORY PHYSICS: An Historical Approach. Herbert Priestley. 515p. \$7.75. Allyn and Bacon, Inc., Boston. 1958.

New, informative, fact-filled text which uses the historical approach to physics to emphasize it is a developing and growing body of knowledge. Should also give the layman better background for understanding modern scientific advances.

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BOWLBY . . . from page 191

"I would rather discover one law of nature than be king." (Democritus)

"Debate answers little, experimentations answer more." (Billett)

Pragmatic

"If you teach a man anything, he will never learn." (Shaw)

"Knowledge without experience is like water without a container." (Confucius)

"Woe to him who teaches man faster than he can learn." (Durant)

Common

"Science tells us how, religion why, life what."

"Education is a trophy rather than a gift."

Double quotations can be developed to illustrate the similarities in the behavior of man and atoms; e.g.:

"Birds of a feather flock together;" "molecules dissolve like molecules."

"We lack fire more than ability;" "matter assumes the lowest state of energy."

The above-mentioned techniques have been designed to produce in the student certain desirable outcomes. This implies objectives or goals of teaching. Many of these, expressed as desired student responses, are listed under the three philosophic headings below.

IDEALISM

to think
understand values
spiritual ideas
mental growth
ideals
extend knowledge
see meanings
be cultural
evaluate
value of past
respect for God
inquire
follow directions
define goals
draw conclusions
good judgment
integrity
love

REALISM

to experiment
understand world
scientific ideas
critical thinking
possibilities
increase knowledge
see relationships
be exact
formulate
value of future
respect for nature
analyze
follow routine
define problems
test conclusions
suspend judgment
accuracy
work

PRAGMATISM

to act
understand life
social ideas
physical growth
better living
use knowledge
see uses
be bold
tolerate
value of present
respect for man
apply
follow leaders
define uses
apply conclusions
democratic judgment
skills
play

Building a philosophical structure in terms of which to relate and evaluate goals and techniques has been a stimulating, rewarding experience. It has brightened the days in the classroom for both myself and my students; it is making me a better teacher and them better learners. Of this I haven't the shadow of a doubt.

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BULLETIN BOARD

Bulletin Board is The Science Teacher's "catchall" feature and will appear when pertinent items warrant its publication. It will carry notices from TST's editors, from NSTA, and from NSTA members or other science teachers who may wish to use it. Its subject matter can be classified "miscellaneous," the basic qualification being that the notice is of interest to science teachers. No commercial items, of course—and TST's editors reserve the right to determine the publication suitability of notices submitted. Write to: Bulletin Board Editor, *The Science Teacher*, 1201 Sixteenth Street, N.W., Washington 6, D. C.

POSTAL ZONES: The U. S. Post Office has asked all publishers and distributors of printed material to include postal zone numbers in addresses. *This is a must* to ensure prompt and accurate delivery of printed materials. If your NSTA membership address does not now include your postal zone number, please report it to NSTA headquarters immediately.

HAWAII WORKSHOP: A "Workshop in Aviation Education" is being sponsored by Pacific Region, Civil Air Patrol; the University of Hawaii; and the U. S. Air Force June 16-July 17, 1958. Open to all teachers, counselors, and school administrators in the U. S. and territories. Six scholarships including tuition fees, air transportation to Hawaii from San Francisco, and hotel accommodation during the five-week workshop sessions are being given by Revell, Inc., of Venice, Calif. For data on the project and scholarships, write to: John V. Sorenson, Director, Aviation Education Workshop, Building T-235, Presidio of San Francisco, Calif.

SUMMER ADDRESSES: If you're changing address for the summer only, please do *not* report the change of address to NSTA. No printed materials are distributed during the summer months.

NEWELL . . . from page 189

third stage has no guidance controls but is spin stabilized. Spinning is begun prior to ignition of the third-stage motor, while still carried by the second stage. The launching vehicle is approximately 72 feet long and 45 inches in diameter at its base. It is finless and has a gross take-off weight of 22,600 pounds. The satellite, actually a test "payload," is an aluminum sphere, 6.4 inches in diameter and weighing about $3\frac{3}{4}$ pounds. It carries two radio transmitters and has six antennas.

Since the purpose of the test payload was to provide radio signals by which the rate of acceleration of the third stage could be determined and the efficiency of the separation mechanism checked, the test satellite carried no instrumentation other than the two radio transmitters. One transmitter, radiating 10 mw at 108.00 mc, is powered by mercury batteries. This transmitter, which was expected to have a life of approximately two weeks, was still operating on April 1, 1958. The other, radiating 5 mw at 108.03 mc, is powered by solar batteries which have an indefinite life.

The frequency of each transmitter is controlled by a quartz crystal. Since changes in crystal temperature will cause changes in the frequency transmitted, temperatures at the crystal locations can be computed by measuring the changes in transmitter frequency. The crystal for the solar-powered transmitter is located just beneath the skin of the satellite; the crystal of the other transmitter is at the center of the satellite. Therefore, temperatures at these locations can be measured whenever the transmitters are in operation.

Six solar batteries are spaced on the surface of the satellite so that at least one of the batteries will be in direct sunlight unless the satellite is in the earth's shadow. Because of the distance of the satellite from the earth, the satellite is expected to be in shadow only 20 per cent of the time.

Each solar battery consists of a series of 18 silicon cells, $1/400$ th of an inch thick, each with two layers of silicon of differing electrical properties. When sunlight strikes the cell, electrons move from the positive layer (p-type) to the negative layer (n-type). The power available to the 108.03 mc transmitter is approximately 40 mw.

The orbit of 1958 Beta is inclined at 34.1° to the equator. Perigee is 404 statute miles, apogee 2466 statute miles, and the period 134.0 minutes.

The third US-IGY satellite, 1958 Gamma, was launched from Cape Canaveral, Florida at 12:38 pm EST, March 26, 1958 by a Jupiter-C rocket similar to that used for 1958 Alpha.

1958 Gamma carries two transmitters, identical with those in 1958 Alpha. The low-power transmitter, operating on 108.00 mc, transmits information continuously on skin temperature and internal temperature, micrometeorite counts as recorded by an erosion grid, and cosmic ray counts. The high-power transmitter, operating on 108.03 mc, transmits only when interrogated by a ground station, and sends only cosmic ray information recorded in a tape recorder memory unit (designed at the State University of Iowa). It is interrogated, by one station only, each time it passes over the Minitrack network along the 75th meridian in North and South America. The signal from the ground station is picked up by a receiver; this starts the magnetic tape running over the playback head and at the same time switches on the high-power transmitter. In five seconds the results of two hours or more of cosmic ray observations are sent to the ground station. The magnetic tape is automatically erased and the recorder reset to record data during the next orbit. By using this interrogation technique, the life of the high-power transmitter is expected to be extended to two months or more. Also, observations are obtained over the whole course of the satellite's orbit instead of those made only when the satellite is above the receiving station.

Because the third stage fired slightly prematurely, before it had reached apex, the orbit of 1958 Gamma is more elliptical than any of the IGY satellites fired earlier. The approximate orbit as of March 28, 1958 was: Period, 115.9 minutes; inclination of orbit to the equator, 33.8° ; perigee, 116.9 miles; and apogee, 1740.8 miles.

It is much too early to expect final scientific results from the satellite program. Yet, as with the rocket program, the preliminary results offer great promise. An analysis of the orbits of the USSR satellites, for example, indicates that the density of the atmosphere at very high altitudes may be several times as great as in previously accepted atmospheric models.

Both the US and USSR satellite programs call for further attempts to launch additional satellites over the coming months. These will be employed in the direct observation of upper atmosphere phenomena, processes, and conditions. Data will be gathered on radiations in the Lyman-Alpha and X-ray regions of the solar spectrum and on cosmic ray intensity, micrometeoritic erosion, the earth's magnetic field, atmospheric density, and temperature. Relations of the data will be extended to include effects upon living organisms. Observations will be coordinated with those made through the use of ground-based balloon and rocket programs.

NSTA Activities

► *Schedule of Meetings*

Smart people don't wait until the last minute to make plans. Smart science teachers will place certain dates for the next school year on their calendar right now. These dates, as you might suspect, are those of meetings of NSTA between now and a year hence.

First on the schedule is the summer meeting, to be held at The Ohio State University, Columbus, June 27-28, just ahead of the NEA summer meeting June 30-July 4 in Cleveland. Detailed programs for the meeting will be mailed to science teachers in Ohio and all "touching" states. If you live beyond this region and are interested, write to NSTA headquarters for the program and information.

Regional meetings will be held next October 17-18 in Pasadena, California and Nashville, Tennessee. Programs for these meetings will be mailed in September to science teachers within the two regions. Chairman for the Pasadena meeting is Mrs. Archie McLean Owen, Board of Education, Los Angeles, California. For the Nashville meeting, Robert T. Lagemann (NSTA Treasurer), Vanderbilt University, is chairman.

The 1958 annual meeting of NSTA, NABT, ANSS, and NARST will be held December 27-30 in Washington, D. C. If interested in attending and you do not receive a program by December 1, write to NSTA headquarters for one.

And, of course, the climax of 1958-59 will be NSTA's 7th annual convention in Atlantic City, New Jersey, April 1-4. Plans are being made to accommodate at least 2000 science teachers since the revised, official count for the Denver convention is 1761 registrants. Start planning now for "time off" to come to Atlantic City—and for ways to get your school board (or other sponsor) to help with your expenses.

► *Elementary Science Conference*

What may well prove to be one of the most significant science education conferences of this decade is soon to be conducted by NSTA. It is an invitational work-conference on elementary school science to be held in Washington, D. C., May 22-24.

Prime purpose of the conference is to develop a report for publication and widespread distribution, one that will give "practical" suggestions and guidelines for developing the elementary science program. The con-

ference will *not* deal with instructional problems of the elementary teacher, but will concentrate on the "headaches" that plague superintendents, supervisors, and building principals as they seek to shape or strengthen the program. Problems of course content, time allotments, selection of instructional materials, in-service help for classroom teachers, and evaluation of a school's science program will receive major attention.

First step in planning consisted of a careful definition of problem areas within the scope of the conference. This was done by a committee comprised of Glenn O. Blough (NSTA President), University of Maryland; Dorothy Alfke, Pennsylvania State University; Paul Blackwood, U. S. Office of Education; and Robert H. Carleton, Executive Secretary of NSTA. These tentative problems have been sent to more than 100 men and women representing major categories of persons concerned with the improvement of elementary school science. The replies of these people will provide experiences, viewpoints, and recommendations to be considered in the conference. Included among the groups whose opinions are being sought—and from which the conferees will be selected—are State Departments of Education, city superintendents, general and special elementary supervisors, teacher education representatives, elementary school principals and teachers, secondary school science educators, and representatives in the areas of the physical, biological, and earth sciences. The conference is made possible by a grant to NSTA from the National Science Foundation.

► *Membership Hints*

Despite the increase in dues, NSTA's rate of membership growth continues to astound. Last May 31 the count was 11,214; the mailing roll for this issue of *TST* will be more than 13,000.

But there are headaches ahead—for our staff and for those members who change their permanent (*not* summer) addresses before next September and do not let us know in advance. *We need at least six weeks notice for proper processing of such changes of address.* Please cooperate—and be sure to include the postal zone number, if any.

One other reminder: Now is "bargain day" in NSTA. All new memberships received between now and next December will be entered for the remainder of 1958 and all of calendar 1959. Tell your friends and colleagues about this. Also, an NSTA membership makes a nice gift for graduation, birthday, or Christmas.



FSA Activities

► Roster of Sponsors

Recession? Late with the FSAF request for contributions for 1958? Will this be the year of the big letdown? Only two months ago we wouldn't have bet more than about \$1.19 against the answers being "No." But today, happy to say, it looks like we would have been wrong, at least on question 3. Nearly 50 per cent of the FSAF budget for 1958 has been contributed. Here is the roster of sponsors who have joined the 1958 list since the April 1958 *TST* report. And several of these have *increased* their grants over what they gave in 1957.

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► Administrative Committee

The agenda for the May 9-10 meeting of the FSAF Administrative Committee called for shaping the program of services and materials to be offered to science

teachers during 1958-59. Details will be announced after the proposals go to the NSTA Board of Directors for approval; this will be done at the Board's annual summer meeting, scheduled this year for June 25-26.

Responsible for planning and overseeing the implementation of the approved programs is the following committee (expiration of term on FSAF Administrative Committee is indicated in parentheses):

Chairman, Dr. Stanley E. Williamson, Professor of Biology and Science Education, Oregon State College, Corvallis (1959).

The following *NSTA Executive Committee members*: President **Dr. Herbert A. Smith**, University of Kansas, Lawrence; President-elect **Dr. Donald G. Decker**, Colorado State College, Greeley; Treasurer **Dr. Robert T. Lagemann**, Vanderbilt University, Nashville, Tennessee; and Executive Secretary **Robert H. Carleton**, NSTA Headquarters, Washington, D. C.

Holdover members: **Dr. Philip G. Johnson**, Cornell University, Ithaca, New York (1960); **Dr. Zachariah Subarsky**, Bronx High School of Science, New York City (1960); and **Dr. Samuel Meyer**, Academic Vice-president, College of the Pacific, Stockton, California—a new position for him as of June 15, for which, "Congratulations!"—(1959).

New appointees to serve three-year terms running through June 1961 are **Dorothy Tryon**, Head of the Science Department, Redford High School, Detroit, Michigan and **Dr. Harold Cassidy**, Associate Professor in Chemistry, Yale University, New Haven, Connecticut.

Retiring members of the FSAF Administrative Committee who have served three-year terms, and to whom we extend sincere thanks and appreciation for their concern and contributions, are: **Katherine Hertzka**, Hoke Smith High School, Atlanta, Georgia, and **Dr. Thomas Osgood**, Director of the School for Advanced Studies, Michigan State University, East Lansing.

► Banner Year for SAA

Youth's intensified interest in science is evidenced by the quality and quantity of the entries in the 1958 program of Science Achievement Awards for Students. New records were set in almost every department. More sets of entry materials were requested by teachers than ever before (31,579 by 2125 teachers); a larger number of students submitted completed project entries; and more students won honorable mention recognition than in any previous year. The number of

winners, as has been specified in the rules of the program for the past three years, was 140—120 regional awards and 20 special national awards. For the list of this year's winners, see page 220 of this issue of *TST*.

This was the seventh year that this program of stimulation and recognition has been made possible by financial support of the American Society for Metals.

It is not too early for teachers to plan on how they will use the SAA program to stimulate and upgrade student activity and achievement during 1958-59. Watch for the official announcement and information, which will be mailed by early October.

Closely related to the SAA program is the certificate for achievement in elementary science which was offered through FSAF this year. This, too, has had a good reception and more than 25,000 certificates have been sent to elementary school principals and supervisors for presentation to pupils who have done outstanding work. The certificates are still available. Are the elementary school authorities in your system aware of this?

Audio-Visual REVIEWS

ANIMALS IN AUTUMN. 11 min. 1957. \$50 B & W, \$100 Color. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: Third through seventh grades in studies of animals' seasonal changes and adaptations.

Content: With effective camera work the film reports how various animals prepare in the fall for the oncoming severe winter season. Among those covered are robins, wild geese, grasshoppers, bees, fish, muskrats, squirrels, the fox, and others.

Evaluation: Fact-filled, informative; outstanding photography. Printed captions add to the film's value.

WHY FOODS SPOIL. 14 min. 1957. \$62.50 B & W, \$125 Color. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: Science and home economics areas in upper elementary, lower junior high grades.

Content: Opening with a pioneer-era scene of a father bringing in meat for the family, the film surveys the methods used then and subsequently to prevent food spoilage. The words *molds*, *yeasts*, and *bacteria* are introduced, followed by effective sequences on each ranging from children growing mold on bread to a bacteria-growing experiment

and the processes of drying, salting, smoking, heating, and freezing foods for preservation. Experiments show why methods of preservation may retard plant growth and how light rays are used to destroy plants that will usually cause food spoilage.

Evaluation: Effectively simple vocabulary, excellent microphotography, appropriately selected children's experiments. Subject matter area is well defined; printed captions are well placed. The teacher's guide is especially good with 12 after-screening problems and activities.

♦ ♦ ♦

MAN IN SPACE. 35 min. 1956. Color. Six-year lease/purchase \$350; ten-year lease/purchase \$300 to educational institutions; one-day rental \$15, additional days \$7.50 per day. Walt Disney Productions, 16-mm Film Division, 2400 Alameda Ave., Burbank, Calif.; 477 Madison Ave., New York City 22.

Recommendation: General science, biology, physics areas in sixth through 12th grades; college biology and beginning physics. Also informative for general public.

Content: A vivid depiction of rocket development from ancient Chinese weapons to modern missiles sets the stage for a provocative film prediction on how man may conquer outer space. But how will mortals react to space travel? To answer this vital question, an animated cartoon character personifying Mr. Average Male endures a harrowing space flight while Dr. Heinz Haber, aviation medicine authority, comments on the problems of weightlessness and other new experiences our hero will meet. In another sequence, Dr. Wernher von Braun illustrates the mechanics of the four-stage rocket which could make interplanetary travel a reality. This leads into a graphic, breath-taking animated cartoon visualization of man's first successful rocket journey to outer space.

Evaluation: Despite recent developments which slightly supersede it, the film contains a wealth of pertinent and vital information for all Americans. It is recommended for general public and/or private showings as well as in schools. Color, photography, and organization are excellent.

♦ ♦ ♦

OUR FRIEND, THE ATOM. 50 min. 1956. Color. Six-year lease/purchase \$400; ten-year lease/purchase \$350 to schools; one-day rental \$25, additional days \$12.50 each. Walt Disney Productions, 16-mm Film Division, 2400 Alameda Ave., Burbank, Calif.; 477 Madison Ave., New York City 22.

Recommendation: Seventh-grade through college physics. Also suitable for lay groups for general information.

Content: Live action and animation are combined to tell the definitive story of the atom and its potential future in the service of peace and progress. This is a comprehensive and detailed film in its presentation of both the historical facts and the implications of the development of atomic energy in the fields of transportation, medicine, agriculture, electric power, and others.

Evaluation: Graphic, authentic, entertaining. The film gives a particularly understandable account of the structure of the atom.

RENNER . . . from page 184

deeply into the basic discipline of physics. If high school is terminal for the majority of students enrolled in physics, it is recommended that the advanced stages of the work be more concerned with everyday application of the principles of physics.

Unit I. Our Mechanical World

1. Force
2. Velocity and acceleration
3. Newton's laws
4. Work, power, energy, and efficiency
5. Review of simple machines
6. Mechanics of liquids and gases
7. Molecular theory

Unit II. Heat and Its Measurement

1. Change of state
2. Transfer of heat
3. Heat and work (first law of thermodynamics)
4. Second law of thermodynamics

Unit III. Sound and Wave Motion

Unit IV. Light and Its Uses

1. Reflection
2. Refraction
3. Color
4. The eye and optical instruments

Unit V. Electricity and Magnetism

1. Review of basic circuits
2. Advanced circuits
3. Magnetic, chemical, and heating and lighting effects
4. Electrical measurements
5. Induction
6. Alternating currents

Unit VI. Radioactivity and Nuclear Energy

Three additional topics are optional. They should be included if student interest warrants.

1. Electronics
2. Television and radio
3. Supersonic missiles and conveyances

Grades 11 and 12—Advanced Biology—Elective

This course is intended to serve only those students enrolled in it in any given year. The authors can easily visualize, for example, that one year the course may be taught entirely for premedical, predental, and prenursing students. Another year, if the interest of the group should shift more toward agriculture and professional entomology, it is entirely possible that the course would be built around crops, crop pests, and the control of these pests. A course of this nature (as does the one

that follows) lends itself very well to project work by the students.

Grades 11 and 12—Advanced Chemistry—Elective

(One semester)

In some localities there is a need for a course in chemistry that approaches an analysis-type course. It would probably be offered by schools in industrial areas where many students terminate their formal education with high school and become employees of these industries. Such a course probably could be designed to fit the industrial needs of a given locality. A course of this nature would also be valuable to college-preparatory students who plan to study chemistry or chemical engineering. Once established, colleges might be willing to grant advanced credit in chemistry to students who had completed the course. In the event that this happens, the course would be serving the dual purpose of college preparation and vocational education. It should be emphasized, however, that the latter is not to suffer for advancement of the former.

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